**VOLUME 1 OF 3**
**FINAL REPORT**



# FINAL DESIGN ALBION-SHERIDAN TOWNSHIP LANDFILL CALHOUN COUNTY, MI

*Prepared for*
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and

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August, 1997

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Woodward-Clyde Consultants (WCC) has prepared this Remedial Design Report (RDR) on behalf of Corning, Inc. and Cooper Industries (The Group) according to the Remedial Design (RD) Work Plan dated June 1996 for the Albion-Sheridan Township Landfill (ASTL) in Calhoun County, Michigan. This RDR has been completed in compliance with the proposed final remedial action presented in the Record of Decision (ROD) and the subsequent Unilateral Administrative Order (UAD) Statement of Work (SOW) issued for the site.

This Remedial Design Report contains the preliminary design for the landfill closure of the ASTL.

## 1.1 PURPOSE OF REMEDIAL DESIGN REPORT

The purpose of this Remedial Design Report is to provide the design for the landfill closure. The final design corresponds with 100% completion of the design. This document also describes the major components of the design approach to meet the design objectives.

## 1.2 ORGANIZATION OF REPORT

The PDR is divided into eleven principle sections:

- Section 1 provides an introduction, provides a site description, and summarizes previous work at ASTL.
- Section 2 provides a description of the remedial action.
- Section 3 defines the design criteria.
- Section 4 presents the design elements and analysis.
- Section 5 describes the plans and specifications.
- Section 6 presents the real estate easements and permit requirements.
- Section 7 discusses the construction schedule and contracting strategy.
- Section 8 presents the capital and operation and maintenance cost estimate
- Appendix A provides supporting documentation.
- Appendix B presents the Performance Monitoring Plan
- Appendix C presents the Draft Construction Quality Assurance Plan
- Appendix D presents the Draft Operation and Maintenance Plan

Additional supporting documentation is included in the Remedial Action Work Plan.

## 1.3 SITE DESCRIPTION

The information contained in Section 1.2 was derived from the Remedial Investigation (RI) Report (WW Engineering & Science, April, 1994), the ROD and SOW.

### 1.3.1 Location

The Albion-Sheridan Township Landfill Site is an inactive landfill located at 29975 East Erie Road approximately one mile east of Albion, Michigan on the eastern edge of Calhoun County (Figure 1-1). The site occupies approximately 18 acres. The site is surrounded by residential, agricultural, commercial and industrial properties. One residence is located immediately adjacent to the landfill to the south and five additional residences are located approximately 1,000 to 1,500 feet (ft) southwest of the landfill along East Erie Road. An active railroad track borders East Erie Road to the south of the landfill, and beyond the railroad tracks lies the North Branch of the Kalamazoo River. South of the river is agricultural land. The site does not fall within the flood plain of the river. There are wetlands south of the site adjacent to the river, separated from the site by the railroad tracks and Erie Road, which are not expected to be impacted by site activities.

The Amberton Village housing development is located adjacent to the site on the east side, with the closest residences approximately 500 ft from the landfill. Several residences and commercial businesses are located along Michigan Avenue approximately 500 ft north of the site. Immediately west of the site is undeveloped land formerly used for agriculture. The Orchard Knoll subdivision is located approximately 1,500 ft northwest of the landfill. Approximately 2,000 ft northwest of the site is a landfill associated with Brooks Foundry. Approximately one mile west is the City of Albion, with a population of 10,066 according to the 1990 census. This figure does not include approximately 1,700 students enrolled at Albion College located in the City of Albion.

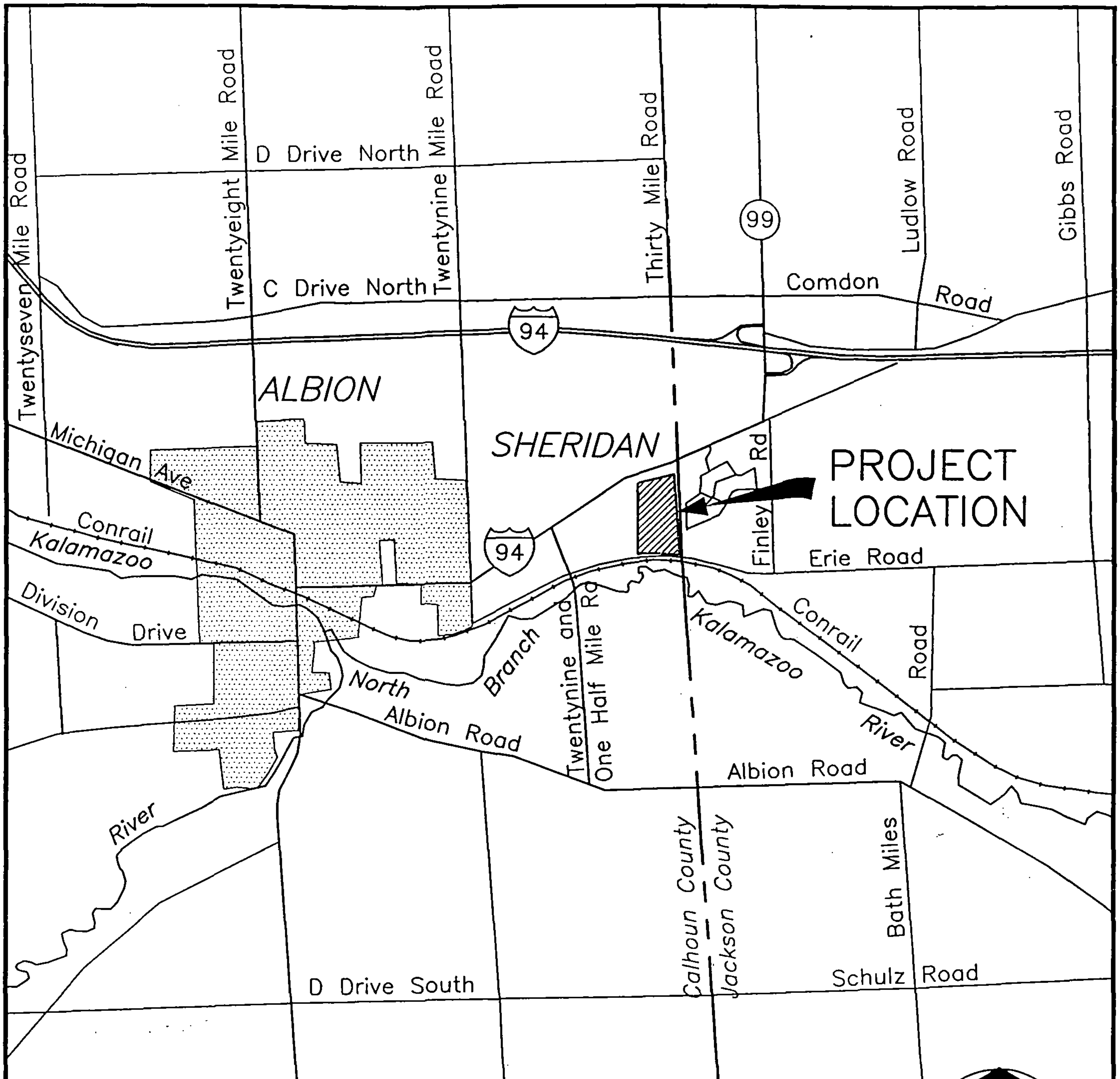
### 1.3.2 History

The ASTL Site had been used as a sand and gravel borrow pit and also used for open, unpermitted dumping for an unspecified period of time prior to 1966. From 1966 to 1981, the landfill was privately owned and operated by Mr. Gordon Stevick. The landfill accepted municipal refuse and industrial wastes from households and industries in the City of Albion and nearby townships. In the early 1970s, the Michigan Department of Natural Resources (MDNR) approved the landfill to accept an estimated 6,000 cubic yards of metal plating sludges. Other materials, such as paint wastes and thinners, oil and grease, and dust, sand, and dirt containing fly ash and casting sand were also disposed of at the site. The landfill ceased operation in 1981.

### 1.3.3 Landfill Characteristics

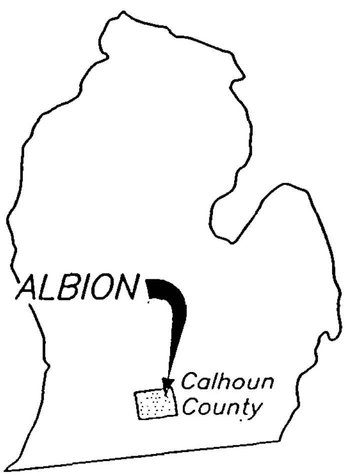
The landfill is currently covered with a 1 to 4 feet thick layer of silty sand with some gravel. The cover thickness averages approximately two feet. Refuse is present within the cover material at some locations, and includes sludge, glass fragments and insulation. Refuse material is scattered at the ground surface throughout the landfill, particularly on the slopes; this material includes metal, plastic, concrete, asphalt, 55 gallon drums, wood, tires, a storage tank, and a junk crane.

The landfill ranges from 16 to 35 ft thick. During drilling of leachate head wells, refuse interlayered with medium to fine sand was encountered. Landfill gases, including total VOCs at concentrations greater than 10,000 ppm, were encountered during the installation of wells and




VICINITY MAP

NOT TO SCALE




ALBION–SHERIDAN TOWNSHIP LANDFILL
ALBION, MICHIGAN

**Woodward-Clyde Consultants**
ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS

SITE LOCATION MAP

| | | | |
|---|---|---|---|
| DRN BY: KAH | DATE: MAY 1997 | PROJECT NO. | FIG. NO. |
| CHK'D BY: DS | DATE: MAY 1997 | 6E13045 | 1-1 |

subsidence monuments on the landfill. Subsurface soil/waste samples contained up to 1,500 ppm total VOCs.

### 1.3.4 Contaminants of Concern

Waste samples from borings contained numerous constituents, including 10 VOCs, 19 semi-volatile organic compounds (SVOCs), and 11 pesticides/PCBs. Several inorganic substances were present above background levels in subsurface soils, including antimony, arsenic, chromium, copper, lead, mercury and zinc. The highest concentrations in soil include lead at 208 mg/kg, arsenic at 13.1 mg/kg and chromium at 13.5 mg/kg. Toxicity Characteristic Leachate Procedure (TCLP) metals analysis results indicated the presence of barium and lead in the leachate, both below hazardous waste levels.

Landfill constituents in groundwater extend southwest of the landfill for approximately 900 ft and extends vertically to a depth of approximately 45 ft below the water table. The unconsolidated aquifer contains 1,2-dibromo-3-chloropropane and antimony at concentrations above their respective federal Maximum Contaminant Level (MCL). The bedrock aquifer plume contains vinyl chloride at the MCL and arsenic above the MCL, at concentrations up to 126 ug/l.

### 1.3.5 Geology

The geology of the site is characterized by approximately 20 to 54 ft thick glacial sediments overlying sedimentary bedrock. The glacial sediments consist of outwash sands and till, while the bedrock consists of fractured sandstone of the Marshall Formation.

Generally, the uppermost portion is composed of outwash sand from the ground surface to a depth of 10 to 30 ft below ground surface. Beneath the outwash sand is a glacial till composed primarily of silty sand with discontinuous layers containing silt and/or clay. There are no obvious clay confining layers beneath the site that are extensive enough to hydraulically isolate the landfill materials from bedrock groundwater.

The uppermost bedrock beneath the site is comprised of Mississippian-aged sandstone of the Marshall Formation. The top of the bedrock beneath the site is generally encountered at an elevation of approximately 935 to 925 feet mean sea level (MSL). The uppermost portion of the sandstone (generally the upper 5 to 25 feet) is intensely weathered. Beneath the weathered portion, the rock is more competent and better cemented; however, it is still highly fractured. The sandstone is characterized by very fine to fine-grained quartz containing trace amounts of pyrite, mica and coal.

### 1.3.6 Groundwater

Groundwater beneath the site is encountered within the unconsolidated and bedrock aquifers. The two units are hydraulically connected in the vicinity of the site as evidenced by water level elevations in nested monitoring wells. In addition, no significant clay layers or aquicludes were encountered during well installation drilling.

Groundwater was encountered in the unconsolidated unit throughout the site at depths of 10 to 30 ft below ground surface. Groundwater was at or very near the ground surface at the well locations adjacent to the North Branch of the Kalamazoo River. The occurrence of shallow groundwater at the site is controlled primarily by infiltration of precipitation and the characteristics of the unconsolidated unit.

The direction of groundwater flow in the unconsolidated unit is west-southwest in the vicinity of the landfill and curves in a more southerly direction near the North Branch of the Kalamazoo River. The average hydraulic conductivity of this unit was determined during the Remedial Investigation (RI) to be 30 ft/day. The groundwater flow velocity in the unconsolidated unit was calculated to be approximately 0.30 ft/day or 100 ft/yr.

Comparing the water level data from both bedrock wells and unconsolidated wells indicates there is a vertical component to groundwater flow. The vertical component of groundwater flow is generally downward in the northern part of the site and upward south of the site near the river. The downward gradient suggests that the northern portion of the site is an area of groundwater recharge, and the upward gradient south of the site is consistent with groundwater discharging to the North Branch of the Kalamazoo River. In addition, there is an upward gradient in the MW04 well between the deep bedrock and the shallow bedrock. This indicates that the groundwater in the deep bedrock is discharging to the shallow and weathered bedrock aquifers, thus helping to protect the deeper groundwater from contamination.

## 1.4 SUMMARY OF PREVIOUS ACTIVITIES

In 1986, a U.S. EPA Field Investigation Team (FIT) contractor, performed a site screening inspection to score the site for the Hazard Ranking System (HRS). In 1988, U.S. EPA proposed that the site be included on the National Priority List (NPL), and in 1989, the site was officially placed on the NPL and designated a Superfund site.

During 1988 and 1989, a U.S. EPA technical team observed surface debris on the landfill, including drums which appeared to contain grease and paint waste. Some of the waste was later classified RCRA hazardous waste for toxicity and ignitability. Some waste samples contained VOCs, including ethylbenzene, toluene, tetrachloroethylene, 1,1,1-trichloroethane, and xylene.

On March 19, 1990, the U.S. EPA issued a Unilateral Administrative Order (UAO) to five potentially responsible parties (PRPs) stating that removal action was appropriate, and on May 3, 1990, the UAO was amended to delete one of the parties.

Later in 1990, two PRPs performed the removal of approximately 46 drums from the surface of the landfill. Twenty two drums were overpacked and sent to an off-site facility for incineration. The remaining 24 drums were crushed and sent to a Type 2 landfill.

In 1991, the site was selected for the presumptive remedy for CERCLA municipal landfill sites, one of the clean-up accelerating Superfund tools.

U.S. EPA initiated the RI/FS in January 1992, and the completed work reports (Final Remedial Investigation Report of the Albion-Sheridan Township Landfill, Albion, Michigan April, 1994 and the Final Presumptive Remedy Feasibility Study Report of the Albion-Sheridan Township Landfill, Albion, Michigan September, 1994) performed by WW Engineering & Science (WWES) were placed in the Administrative Record in late 1994.

U.S. EPA decided on a remedial action to be implemented at the site and executed a ROD on March 1995, on which the state has given its concurrence.

On June 6, 1995, the U.S. EPA issued special notice letters to respondents to initiate negotiations on a consent decree for performance of the Remedial Design/Remedial Action (RD/RA) for the site. Respondents declined to enter into a consent decree to conduct the RD/RA for the site in accordance with the ROD and the Statement of Work (SOW) for the site so the Agency issued an Unilateral Administrative Order (UAO) on October 11, 1995.

The Group retained WCC in March, 1996 to assist their implementing the RD/RA. WCC completed pre-design studies field work during August, 1996 and completed the Pre-Design Studies Report, Albion-Sheridan Township Landfill Calhoun County, Michigan, dated December, 1996 (PDR) which was approved by U.S. EPA on December 4, 1996. The pre-design studies consisted of installing additional groundwater monitoring wells, groundwater sampling and analyses, site surveying, further delineating the horizontal and vertical extent of waste, performing a native species revegetation study and conducting an air emissions study. The following sections briefly summarize the results of the pre-design studies.

### 1.4.1 Additional Monitoring Well Installation

Four ground water monitoring wells were scheduled to be installed during the pre-design studies. However, due to the inability to reach a monitoring well access agreement with the landowner (Walt Gill and Sons), two monitoring wells (MW15SB and MW 09DB) could not be installed.

Two monitoring wells (MW16SB and MW16DB) were installed during the week of August 5-12, 1996, by Environmental Drilling and Contracting, Inc. of Holland, Michigan. All drilling and well installation was supervised and documented by WCC personnel.

### 1.4.2 Groundwater Sampling and Analyses

Groundwater samples were collected on August 13-15, 1996 from all existing and new monitoring wells located at the site and adjacent properties as indicated in Figure 2. Verbal permission was received from Mr. Dick Gill prior to accessing his property.

Samples collected for laboratory analysis from each monitoring well were analyzed for:

- Target Compound List - Volatile Organic Compounds (TCL-VOCs)
- TCL-Semi-Volatile Organic Compounds (SVOCs)
- TCL-Pesticides/Polychlorinated biphenyls (PCBs)
- Target Analyte List (TAL)-Metals (Dissolved)
- Cyanide (Total)
- 1,2-dibromo-3-chloropropane

Field measurements of pH, specific conductance, dissolved oxygen (DO), Eh, temperature, depth of water, and groundwater elevation for all of the wells were obtained during the pre-design study and are summarized in the PDR.

## *Organic Analyte Analyses*

MW03SG sample results revealed vinyl chloride present at the quantitation limit of 1.0 μg/L and MW07SG sample results revealed chloroethane present at the quantitation limit of 1.0 μg/L.

Bis (2-Ethylhexyl) phthalate was the only semi-volatile organic compound (SVOC) detected. It was detected in MW05SG at 6.4 μg/L which is above the 6.0 μg/L MCL. MW05SG is an upgradient monitoring well, according to documented groundwater elevations.

There were no other detections of VOC or SVOC compounds in the consolidated (bedrock) monitoring wells.

## *Inorganic Analyte Analyses*

Inorganic analyte results from wells screened in the unconsolidated sediments are summarized as follows:

- Cadmium, cyanide and zinc were not detected.
- Arsenic was detected in 3 groundwater samples, all below the 50 μg/L MCL. Arsenic concentrations ranged from 7.9 μg/L in MW04SG to 13.2 μg/L in MW07SG.
- Calcium results ranged from 46,400 μg/L in MW08SG to 145,000 μg/L in MW03SG.
- Antimony was detected in MW01SG at 5.7 μg/L and in MW12SG at 5.6 μg/L.
- Iron was detected in 7 monitoring well samples ranging from 140 μg/L in MW12SG to 4,320 μg/L in MW03SG.
- Potassium was only detected in MW03SG and MW07SG at 22,600 μg/L (23,400 μg/L in duplicate sample) and 25,300 μg/L, respectively.
- Magnesium was detected in all monitoring well samples ranging from 11,800 μg/L in MW12SG to 53,200 μg/L in MW03SG.
- Manganese was detected in all monitoring well samples, except for MW01SG and MW08SG, in concentrations ranging from 38.1 μg/L in MW09SG to 465 μg/L in MW13SG.
- Sodium was detected in all monitoring well samples, except MW01SG, MW04SG, MW06SG and MW08SG, in concentrations ranging from 5,310 μg/L in MW09SG to 141,000 μg/L in MW03SG.
- Iron levels exceeded the 300 μg/L aesthetic drinking water value at MW03SG and MW07SG with levels of 4,320 μg/L and 4,050 μg/L, respectively.
- Manganese levels exceeded the 180 μg/L residential cleanup criteria in upgradient wells MW02SG (194 μg/L) and MW05SG (183 μg/L) and in downgradient wells MW03SG (352 μg/L), MW07SG (1,270 μg/L) and MW13SG (465 μg/L).

Inorganic analyte results from wells screened in the bedrock are summarized as follows:

- Arsenic exceeded the 50 µg/L MCL in MW06SB at a concentration of 130 µg/L. Arsenic was also detected in MW04SB (10 µg/L), MW04WB (15.8 µg/L), MW06WB (32.9 µg/L) and MW16SB (7.9 µg/L).
- Cadmium was not detected in any of the bedrock monitoring wells.
- Antimony was only detected in MW09SB at 5.2 µg/L and zinc was only detected in MW04DB at 29.6 µg/L and MW07WB at 43 µg/L.
- Calcium was detected in all bedrock monitoring well samples at concentrations ranging from 54,800 µg/L in MW08WB to 148,000 µg/L in MW03WB.
- Iron was detected in all bedrock monitoring well samples except MW04SB, MW07SB and MW09WB. Iron concentrations ranged from 186 µg/L in MW08WB to 5,330 µg/L in MW03WB.
- Potassium was detected in all bedrock monitoring well samples except MW04DB, MW07SB, MW07WB, MW08SB, MW08WB and MW16DB at concentrations ranging from 6,420 µg/L in MW05SB to 45,400 µg/L in MW04SB.
- Magnesium was detected in all bedrock monitoring well samples except, for MW07SB, at concentrations ranging from 14,500 µg/L in MW08WB to 51,700 µg/L in MW03WB.
- Maganese was detected in all bedrock monitoring well samples, except for MW07SB, at concentrations ranging from 25.4 µg/L in MW08WB to 297.0 µg/L in MW03WB.
- Sodium was detected in all bedrock monitoring well samples, except for MW08WB, at concentrations ranging from 8,310 µg/L in MW04DB to 151,000 µg/L in MW03WB.
- Iron levels exceeded the 300 µg/L aesthetic drinking water value at all bedrock monitoring wells except MW02SB, MW02WB, MW04SG, MW04SB, MW07SB, MW08WB and MW09WB.
- Manganese exceeded the 180 µg/L residential cleanup criteria in upgradient wells MW01WB (333 µg/L) and in downgradient wells MW03WB (297 µg/L), MW04SG (16,900 µg/L - 18,100 µg/L in FD-2) and MW16SB (202 µg/L).

### 1.4.3 Site Surveying

The accuracy of the existing topographic map (WW Engineering & Science, April, 1994) and boundary information completed during the RI was verified using standard surveying practices and existing benchmarks by a licensed surveyor, Atwell-Hicks, Inc., Ann Arbor, Michigan. The location and elevation of the two new monitoring wells and test pits were also surveyed by Atwell-Hicks, Inc.

The existing topographic information provided from the WW Engineering & Science aerial survey of the Albion-Sheridan site from 1994 was determined to have some inconsistencies when compared to the random topographic checks provided by the 1996 Atwell-Hicks pre-design survey. The random survey points generated from the ground survey indicate the topographic information from the 1994 aerial survey on the south end of the landfill property is approximately two (2) to five (5) feet above the actual existing ground surface. Subsidence data provided in the WW Engineering & Science investigation reports and confirmed in the 1996 survey can not substantiate any large changes in elevation over this section of the landfill site. By eliminating subsidence, the conclusion reached is that the original aerial topographic survey was inaccurate. This could be attributed to a variety of factors, but most likely due to the effect trees and vegetation that mask the actual ground elevation for aerial photo interpretation.

### 1.4.4 Additional Horizontal and Vertical Waste Delineation

The waste fill area characterization was completed in compliance with Technical Memorandum No. 1 dated June 31, 1996. The purpose of this task was to gather further information on the vertical and horizontal extent of waste in order to analyze the design for potential footprint consolidation of the cover system. The schedule for these activities was coordinated in conjunction with the groundwater well installation/sampling and occurred on August 9-13, 1996. All work was completed in Level D personal protective equipment as the air monitoring results at test pit locations during excavation did not exceed action levels. Twenty-six test pits were completed to determine the horizontal extent of waste and eight test pits to determine the vertical extent of waste.

The horizontal edge of waste was found to generally conform to the edge of waste shown in the RI. Areas where the boundary differed were on the south and east edges of the landfill. The previous horizontal waste boundary that was outlined in the RI indicated approximately 17 acres of the site contained waste. Based on the edge of waste locations verified by this study, the waste area can be more accurately estimated at 16 acres.

Wastes encountered during the test pit excavations tended to be industrial and household waste on the major portion of the landfill. The areas north and northeast of leachate monitoring well LF-1 contained waste that consisted of large pieces of metal slag, foundry sand, and based on odor, appear to be petroleum contaminated soils.

The composition of waste observed during the vertical extent of waste investigation supported the observations made in the horizontal extent investigation as to the waste composition in the various sections of the landfill. The bottom extent of waste was located at four (4) of the eight (8) test pits that were excavated. The other test pits encountered waste deeper than the digging capabilities of the backhoe (greater than 18 feet) and further excavation was not done in these areas. No drums were found during the extent of waste investigation.

### 1.4.5 Native Species Revegetation Study

The purpose of this study was to evaluate the costs and practicability of revegetating the ASTL cap with native species. The study concluded that revegetating the landfill cap at ASTL with native species has substantial merit and will be implemented.

### 1.4.6 Air Emissions Study

The SOW for the remedial action at the ASTL establishes the requirements for performance of the remedial action. One of these requirements is the following:

*At all times during the performance of the remedial action, air emissions shall not exceed a total cancer risk of $1 \times 10^{-6}$ at the fenceline, using risk calculation methods set forth in Risk Assessment Guidance for Superfund. In addition, the air emissions shall not exceed any Applicable or Relevant and Appropriate Requirements (ARARs).*

WCC used two different computer models (Landfill Air Emissions Estimation Model USEPA, 1991, Landfill Air Emissions Estimation Model, EPA-600/8-90-085a, April 1991 and Air/Superfund National Technical Guidance Study Series, Models for Estimating Air Emission Rates from Superfund Remedial Actions, USEPA 1993) to predict chemical-specific landfill gas generation rates and downwind concentrations of these chemicals to demonstrate that the total cancer risk level of $1 \times 10^{-6}$ will not be exceeded at the fenceline from landfill remediation and waste consolidation activities.

The long-term concentrations for all nine carcinogenic compounds were compared to the MDEQ screening levels (IRSLs). The models determined that none of the chemical concentrations exceeded the screening levels and the risk level of $1 \times 10^{-6}$ ($9.30 \times 10^{-7}$ actual) would not be exceeded for any individual compound.

The final step was to ensure that the sum of the individual risks does not exceed $1 \times 10^{-6}$. The unit risks were multiplied by the long-term concentrations to determine individual cancer risks. The individual risks were then added together to determine the total cancer risk at the fenceline. The total cancer risk did not exceed $1 \times 10^{-6}$. Therefore, the SOW requirement is expected to be complied with at all times.

Based on the results, the SOW requirements will be met by a passive gas venting system without any controls on gas emissions. It should be noted that the Landfill Air Emissions Model predicted a decreasing trend in the gas production rate starting approximately 2 years after landfill closure (1981).

## 1.5 SCOPE OF WORK CHECKLIST

The SOW (Page 13) details eleven items to be submitted as part of the preliminary final design. For information and review purposes the eleven items and their location in the PDR are listed below.

| SOW Requirement | Report Location |
| --- | --- |
| Plans, drawings, and sketches, including design calculations | Sections 3-5, Drawing 10 and Appendix A |
| Design assumptions and parameters, including design restrictions, process performance criteria, appropriate unit processes for the treatment train, and expected removal or treatment efficiencies for both the process and waste (concentration and volume) | Sections 3-5 |
| Proposed cleanup verification methods, including compliance with Applicable or Relevant and Appropriate Requirements (ARARs) | Section 3 |
| Specifications. | Appendix E |
| Proposed siting/locations of processes/construction activity | Section 4 |
| Expected long-term monitoring and operation requirements | Appendix D |
| Real estate, easement, and permit requirements | Section 6 |
| Preliminary construction schedule, including contracting strategy | Section 7 |
| Final Performance Monitoring Plan | Appendix B |
| Final Construction Quality Assurance Plan | Appendix C |
| Final Contingency Plan | The contingency plan will be included in the site health and safety plan prepared by the RA Contractor. |
| Draft Operation and Maintenance Plan | Appendix D |

2

## 2.1 PURPOSE

The purpose of remedial action at the ASTL Site is to reduce the risks associated with exposure to the contaminated materials on-site, to eliminate or reduce migration of contaminants to groundwater and to reduce the risks associated with arsenic contamination in the groundwater. The ROD describes the remedy as restrictive covenants/deed restrictions, drum removal, and the installation of a flexible membrane lined cap and gas collection system. The ROD also describes a contingent groundwater remedy if appropriate groundwater standards are not achieved..

The remedial action was selected in accordance with two threshold criteria, overall protection of human health and the environment, and compliance with the requirements of Federal and State Applicable or Relevant and Appropriate Requirements (ARARs).

The ROD requires design and implementation of the remedial action to meet the performance standards and specifications set forth in the ROD and the SOW. The performance standards include clean-up standards, standards of control, quality criteria and other substantive requirements, criteria or limitations including all ARARs set forth in the ROD, SOW and/or UAO.

## 2.2 DESCRIPTION OF REMEDIAL ACTION

The remedial action is summarized below and described further in the design documents:

### *Site Security*

A permanent fence shall be installed and maintained at the site to prevent access and vandalism to the site. The site security system of the landfill shall:

- Consist of a minimum 6 ft high fence, with a minimum three-strand barbed wire permanent chain link fence and gates around the perimeter of the landfill.
- Encompass at a minimum the landfill waste.
- Post warning signs at 200 ft intervals along the fence and at all gates.
- The permanent fence shall be completed within 30 days of the landfill cap completion. The warning signs shall:
    - Advise that area is hazardous due to chemicals in the soil which pose a risk to public health through direct contact with soils.
    - Provide a telephone number to be used for further information.

### *Restrictive Covenants/Deed Restriction*

Future development including, but not limited to, on-site excavation, construction and drilling shall be prohibited. The prohibition is achieved by filing with the Calhoun County recorder the restrictive covenants included in Appendix E of the UAO.

Institutional controls in the form of deed restrictions or a local ordinance shall be implemented to prohibit the installation of any groundwater well which draws drinking water from the area noted in Figure 4 of the ROD to contain 2 ug/l of arsenic or more.

All restrictions regarding future development of the landfill shall be considered permanent. U.S. EPA may advise lifting the restrictions on future groundwater drinking water well installation when the arsenic concentrations in the groundwater area described in Figure 4 of the ROD remain below the MCL for two years.

### *Drummed Waste*

Test pit area TP09 shall be excavated to uncover all drums. Solid or liquid waste drums from area TP09, nine drums previously excavated by the MDNR temporarily stored on site, and drums encountered during consolidation or site preparation determined by the drum removal contractor to be structurally sound, shall be removed to the staging area for waste characterization.

Where practical, liquid wastes from structurally unsound drums encountered at TP09 area, or during consolidation or site preparation, shall be removed and transported to the staging area for subsequent characterization.

Excavated drums showing signs of degradation shall be overpacked. The overpacked drums shall be included with the on-site overpacked drums, temporarily secured on the surface of the landfill during test pitting. Overpacked drums shall be submitted for Resource Conservation and Recovery Act (RCRA) characterization and to determine disposal options.

The ROD requires that all excavated drums containing liquid and solid wastes containing constituents in concentrations exceeding land disposal restrictions or constituents for which incineration or stabilization treatment method is prescribed to be treated or disposed off-site.

Drums containing solid wastes not banned by land disposal restrictions, may be incorporated under the ASTL cap.

### *Landfill Cap*

The landfill cap will cover the entire landfilled waste mass as delineated in the PDR. The landfill cap will meet or exceed the substantive requirements of RCRA subtitle D (40 CFR Part 241) and any more stringent requirements of Michigan NREPA 451, 1994 Part 115 which are applicable or relevant and appropriate to the site as determined by the U.S. EPA. The multi-layer landfill cover design at a minimum will include (from the surface downward):

- Vegetative Cover: Native plant species will be used to establish a vegetative cover to control erosion.
- Topsoil Layer: The topsoil layer, which is a minimum of 6 inches (in) thick, will be placed to sustain plant growth, control erosion and promote drainage.
- Cover Soil Layer: The cover soil layer will be 18-in thick.
- Drainage Layer: The drainage layer will consist of a geonet synthetic material with a transmissivity of at least 3 x $10^{-5}$ $m^2$/sec.

- Flexible Membrane Liner (FML): The FML will be equivalent to or less permeable than a 40 mil low density polyethylene (LDPE), or 30 mil polyvinyl chloride (PVC).
- Gas Collection Layer: The gas collection layer will consist of a 12-in. thick sand layer on top of the existing waste mass.

The following components were identified in the SOW as parts of the construction and installation activity of the landfill cap:

- Consolidating the waste on the east edge of the landfill towards the west so that the east boundary of the landfill cap and any perimeter road needed for maintenance is contained on lot 28.
- Consolidating the waste on the south edge of the landfill so that the south boundary of the landfill cap and any perimeter road needed for maintenance is contained in lot 28, parcel 3, and parcel 2 north of a line extending to the east from the north boundary of parcel 1. If lot 28 parcels 1 and 2 are acquired, waste consolidation of the south edge will not be necessary.
- Grading the landfill to attain grades and slopes required to facilitate drainage and to meet ARARs. Regrading may be used to achieve sub-cap contours. Off-site clean fill can only be employed for grading with prior EPA approval.
- Abandoning (pull casing and seal with grout), prior to construction of cap, leachate monitoring wells LF01, LF02, and LF03.
- Closing and abandoning, prior to pre-final construction inspection, monitoring wells MW-West, MW-South and MW-East. All well abandonment and closure shall be in accordance with Michigan Act 315.
- Tree removal/conservation. Where possible, existing trees outside of the landfill cap area will be preserved.

The Group has proposed technical equivalents to the ROD and SOW requirements related to grading materials, cover system materials (drain layer) and the landfill gas system (venting wells and gas collection layer). The proposed modifications are detailed in Section 3.3.

### *Monitoring Program*

Monitoring programs will be designed and implemented to evaluate and ensure that the remedial action complies with approved plans. The programs consist of:

- A groundwater monitoring program to detect changes in the chemical concentration of the groundwater at and adjacent to the site following completion of the remedial action.
- An air monitoring program to detect air emissions from the landfill during and after the remedial action.

### *Contingent Remedy*

A contingent remedy may be required at a later date to address groundwater. Five years after the completion of the landfill cap, a statistical test shall be completed on data from wells where the arsenic concentration has exceeded the MCL (0.05 mg/l) at any time during the monitoring period. The SOW requires a contingency remedy be implemented if:

- The statistical test results show that arsenic concentrations will not decline below 0.05 mg/l within 15 years of landfill cap completion, and/or
- The groundwater plume affected by the landfill threatens to raise arsenic concentration in a residential well that existed on the day the ROD was signed to levels above 0.05 mg/l.
- Preparation of a work plan, conducting pilot tests, designing and installing an in-situ groundwater oxidation system capable of restoring groundwater to performance standards will be required if any of the wells fail the statistical test. The contingent remedy description and requirements are further detailed in the ROD and the SOW.

The groundwater treatment system will be included in the contingent remedy and shall consist of a network of wells designed to increase oxidation of all contaminated groundwater that exceeds the MCL for arsenic to result in arsenic precipitation from the groundwater.

Groundwater treatment shall continue in each well designated for performance monitoring until the MCL performance standard for arsenic (0.05 mg/l) is attained. If no wells fail the statistical test for arsenic concentration, and the groundwater plume does not threaten residential wells, a contingent remedy will not be required; however, groundwater monitoring shall continue for at least five years following attainment of the arsenic performance standard.

3

This Section presents the remediation action design criteria based on Applicable or Relevant and Appropriate Requirements (ARARs) and SOW requirements. A summary of these requirements is presented in Table 3-1. Detailed discussions of ARARs were presented in the Final Presumptive Remedy Feasibility Study Report (WW Engineering and Science, September, 1994) and the Record of Decision.

## 3.1 KEY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Key ARARs are summarized as action, chemical and location specific.

### 3.1.1 Action Specific

Resource Conservation and Recovery Act (RCRA)

RCRA Subtitle C requirements are relevant and appropriate to the portion of remedy involving off-site treatment of drummed waste with hazardous characteristics. RCRA subtitle D (40CFR Subtitle D Part 258) is appropriate to the cover system.

Michigan Environment Response Act (Act 307 and Act 451 Part 201) -- Michigan Admin Code R. 299.601 et. seq.

Act 307 requirements are relative and appropriate with respect to Type C cleanup. Type C cleanup requires long term monitoring to assess the effectiveness of on-site containment of hazardous substance.

Solid Waste Management Act (Act 641 and Act 451 Part 115) -- Michigan Code R. 299.401 et. seq.

Parts 3 and 4 requirements are relevant and appropriate to cover system, gas control and groundwater monitoring.

Clean Air Act (CAA)

New Source Performance Standards (NSPS) Title III applies if emissions from the site reach threshold limits of 10 tons per year hazardous air pollutant or 25 tons of any combination.

Michigan Air Pollution Act (Act 348) -- Michigan Admin. Code R. 336.1901 et. seq.

Act provides for fugitive dust and emissions control during and following construction.

Occupational Safety and Health Act (OSHA)

OSHA 29CFR1910 requirements are applicable to work at the site to protect the health and safety of workers.

Michigan Soil Erosion and Sedimentation Act (Act 347)

Act 347 requirements are applicable to any earth changes within 500 feet of a lake or stream.

Michigan Comp. Laws Ann. Section 257.722 ("Frost Laws")

"Frost Law" requirements are applicable to off-site activities on Michigan highways.

## TABLE 3-1
## APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) SUMMARY FOR ALBION-SHERIDAN COVER DESIGN

| DESIGN FEATURE | REGULATION/RULE | REQUIREMENT |
|---|---|---|
| Site Grading | NREPA Act 451<br><br><br>Michigan Air Pollution Act 348 | Final Grades:<br>- Min. 4%<br>- Max. 25%<br>Rule 371 requires fugitive dust control |
| Drum Removal | SOW | Sampling, Analysis, Transportation and Disposal Activities to meet subtitle C requirements |
| Site Security | SOW | Six foot chain link with three-strand barbedwire<br>Encompass waste (as a minimum)<br>Post warning signs at 200-foot intervals |
| Waste consolidation | NREPA Act 451 | Placement of Waste:<br>- in compliance with landfill operation requirements<br>- 6 inches daily cover<br>- compacted in 24 inch lifts. |
| Stormwater Management<br>Erosion Control | NREPA Act 451<br><br><br><br><br>Michigan Soil Erosion and Sedimentation Act, Act 347<br><br>Rule 323.2190(a)(b) | Control stormwater from 24 hour 25 year storm<br>Requires a layer to protect from wind and water erosion<br>Erosion < 2 tons/acre/year<br>Earth Changes:<br>- > 1 acre<br>- 500 feet from a lake or stream<br>Erosion Control for activities:<br>- > 5 acres |
| Cover System Components | NREPA Act 451 | Top Soil:<br>- 6-inches thick<br>- Capable of supporting vegetation |

| DESIGN FEATURE | REGULATION/RULE | REQUIREMENT |
|---|---|---|
| Cover System Components (cont.) | | Common Fill/Protective Soil Layer:<br><br>- **provide lateral drainage**<br>- 24 inches thick (including topsoil)<br><br>Drain Liner:<br>- Synthetic layer with transmissivity greater that $5x10^{-5}$ $m^2$/sec, or<br>- 6 inches thick sand with minimum permeability of 1 x $10^{-2}$ cm/sec<br>Liner Cap<br>- Minimum 40 mil LLDPE FML |
| Gas Collection and Venting System | NREPA Act 451 | Gas Venting System:<br>- 1 foot sand layer<br>- gas risers<br>- no lateral travel or gas accumulation |
| Landfill Gas Monitoring | Rule 299.4433 | Less than 25% LEL at property boundary |
| Stability Control | NREPA Act 451 | Stabilize cover by appropriate:<br>- soil type<br>- slope<br>- moisture content |
| Groundwater Monitoring and Analyses | SOW | Quarterly Monitoring<br>Annual Monitoring<br>Residential Well Monitoring<br>5 Year Review Monitoring |
| | Michigan Act 641 | As per SOW Requirements |
| General Operation and Maintenance | 40 CFR 264.117(a)(1 | Post Closure Care:<br>- begins after completion of closure |

### 3.1.2 Chemical Specific

Safe Drinking Water Act (SDWA)

SDWA requirements are relevant and appropriate to groundwater remedies at the site.

### 3.1.3 Location Specific

Executive Order on Flood Plain Management Exec. Order No. 11.988; 40CFR6.302(b)

Executive Order No. 11.988 requirements are applicable for those portions of the selected remedy and contingent remedy that occur in the flood plain.

Executive Order On Protection of Wetlands Exec. Order No. 11.900; 40CFR6.302(a)

Executive Order No. 11.900 requirements are applicable where portions of the selected remedy and contingent remedy have potential to impact wetlands.

Endangered Species Act 16 USC.1531 et. seq.; 50CFR Part 200, 50CFR part 802

Act requirements are not applicable. No endangered species are present on the site.

## 3.2 EXISTING CONDITIONS

The landfill surface has significant areas with slopes below minimum requirements for closure. The surface has poor vegetation with brush and small trees. The landfill has minimal cover material (RI indicates one to four feet) consisting of on-site silty sand with gravel soil material mixed with debris in some locations. Debris and other junk materials are scattered over the surface.

Waste extends beyond the property boundaries to the east and south and to the boundary on the west. A security fence was installed beyond the extent of waste and property line during the RI.

## 3.3 EVALUATION OF ALTERNATIVE MATERIALS AND DESIGN ELEMENTS

In summary, concurrence on use of the following alternative design and construction materials is requested:

1. Use of consolidated waste and on-site borrow materials for grading site to minimum slopes.
2. Use of a geonet/geotextile composite as a synthetic equivalent to the sand drain layer.
3. Use of on-site granular permeable soils with 12% or less fines and horizontal vent wells and risers to meet landfill gas control requirements. Use of on-site borrow materials is pending based on testing results.

The SOW and Feasibility Study described specific designs and materials for certain elements of the closure construction:

- Grading Materials; "Respondents may only use off-site materials for fill if those materials are approved by U.S. EPA, in consultation with MDNR, prior to use" (SOW, pg. 2, U.S. EPA, 1995)
- Cover System Materials, Drain Layer; "A 6 inch sand drainage layer or technical equivalent... The drainage layer will be composed of sand no coarser than 3/8 inch, with a minimum hydraulic conductivity of $1x10^{-2}$ cm/sec or synthetic material with a transmissivity of at least $3x10^{-5}$ $m^2$/sec." (ROD, pg. 25, U.S. EPA, 1994)
- Landfill Gas System, Gas Collection Layer; "...the cap will consist of a 12 inch sand gas collection layer on top of existing waste mass ..." (ROD, pg. 25, U.S. EPA, 1994).
- Landfill Gas System, Venting Wells; "... a system of venting wells may be constructed across the landfill to vent landfill gas to the atmosphere. The gas collection or venting wells will be constructed to collect gas from the entire area and depth of the landfill." (ROD, pg. 25, U.S. EPA, 1994)

One objective of the design modifications/alternative materials is to fully utilize on-site soil materials and minimize environmental impacts to the site from the truck traffic associated with the importing of material which involve issues of road damage, congestion, dust and noise. The combination of on-site borrow sources and use of alternative designs could reduce truck traffic from an estimated 4,000 trips to the minimum traffic required for mobilization, synthetic materials and topsoil materials. This will substantially reduce environmental impacts of construction, schedule constraints imposed by truck traffic and overall project costs. The two roads most likely to be used for the transporting of this material would be Erie Road and State Route 99. Access from State Route 99 will require an easement from the property owner on the north end of the site. In addition, use of on-site materials will reduce the project schedule's dependence on winter or spring road restrictions on importation of materials. Sections 3.3.1 through 3.3.3 support the design modifications and use of alternative materials.

### 3.3.1 Grading Materials

The SOW states, "Respondents shall grade the landfill to attain grades and slopes required to facilitate drainage contours approved in the Remedial Design (RD). Respondents may only use off-site and to meet ARARs. Respondents may regrade the landfill as necessary to achieve sub-cap materials for fill if those materials are approved by U.S. EPA, in consultation with MDNR, prior to use." (SOW, pg. 2, U.S. EPA, 1995)

Much of the landfill surface currently does not meet minimum slopes required by MDEQ solid waste regulations. One method to achieve these grades is to import soil material to grade the landfill surface to the minimum four (4) percent slope. Preliminary calculations indicate approximately 41,000 cubic yards (in place) would have to be imported for this purpose.

Alternately, it is proposed to consolidate sufficient amounts of waste from the east perimeter of the landfill area to achieve the minimum required slopes. It is also proposed to use borrow material from or adjacent to the site to place the daily cover and gas collection/foundation layer pending testing results. Waste consolidation and on-site materials will replace the imported materials significantly reducing rough grading costs and significantly reduce truck traffic and associated environmental impacts and schedule constraints.

### 3.3.2 Drain Layer Materials

The ROD indicates specific design criteria/specifications for the drain layer. Materials to be used for the six (6) inch thick drainage layer shall be "a sand no coarser than 3/8-inch, with a minimum hydraulic conductivity of $1x10^{-2}$ cm/sec, or a synthetic material with a transmissivity of at least $3x10^{-5}$ $m^2$/sec".

On-site soils will not meet the hydraulic conductivity criteria of $1x10^{-2}$ cm/sec. As a result, the design incorporates a synthetic drainage material. A geotextile/geonet composite component will be used consisting of a non-woven geotextile heat bonded on both sides of a HDPE geonet. This synthetic will meet the minimum transmissivity requirement of $3x10^{-5}$ $m^2$/sec.

### 3.3.3 Passive Gas Venting System

The Pre-Design Studies (WCC, 1996) determined that an active gas collection and treatment system is not required. The ROD then requires the cap to include "a 12 inch sand gas collection layer on top of existing waste mass" and "a system of venting wells constructed across the landfill to vent landfill gas to the atmosphere. The gas venting wells will be constructed to collect gas from the entire area and depth of the landfill".

Act 641, Rule 425 requires the final cover to have either of the requirements of R299.443: (a) a permeable soil layer which is not less than 1 foot thick and which is located directly below the infiltration layer that vents gas to gas risers, (b) other means of assuring that gasses cannot travel laterally from the site or accumulate in structures. Only on-site sand as defined by the United Soil Classification System with 12% or less fines will be used in this layer.

The ROD and FS describe a passive gas venting system composed of a permeable gas venting layer 12 inches thick combined with 15 vertical gas vent wells with risers. It is proposed to utilize horizontal vent wells in trenches to more effectively vent the entire area and depth of the landfill. Lateral spacing to the horizontal vent wells at 190 feet with risers every 200 feet provide over 2300 feet of pipe with atmospheric pressure to vent the landfill. Maximum travel distance for landfill gas to piping with atmospheric pressure using vertical vent wells is 141 feet while the maximum distance for horizontal vent wells is 105 feet.

## 3.4 DRUM REMOVAL

Steel drums located in TP-9 Area or discovered during other closure construction work will be relocated to a drum staging area. The drum staging area will be situated due south of the TP09-drum area at the southern edge of the waste consolidation area. A staging area will be constructed that is lined with an FML and bermed to contain potential spills and leaks resulting from drum handling.

The drums will be characterized to determine the appropriate disposal method. After characterization, those solid wastes found to contain organic and/or inorganic constituents in concentrations exceeding land disposal restrictions, or constituents for which incineration or stabilization as a treatment method is prescribed, will be transported to off-site facilities for treatment. All liquid wastes will be transported to off-site facilities for treatment and/or disposal. Other non-hazardous drums will be crushed and placed in the landfill fill area. Sampling, analysis, off-site transportation and disposal will be consistent with RCRA Subtitle C requirements and EPA's Off-Site Rule. The contractor will implement the waste characterization/disposal process described in the Drum Management Plan (Appendix C of the Remedial Action Workplan, Volume 2).

The underground storage tanks (USTs) located on the east side of the site will be excavated and disposed of at the same time of the drum removal activities. Any liquids in the USTs will be removed and characterized along with the drum wastes. The USTs and associated piping will then be excavated, crushed and incorporated under the cap.

## 3.5 WASTE CONSOLIDATION AND SITE GRADING

Site Grading design criteria are:

- Minimum 4% slopes
- Maximum 25% slopes

Waste consolidation design criteria are:

- Remove all waste and visibly stained soils
- Compact consolidated waste in 2 foot lifts with trash compactor
- Apply 6 inch daily cover to consolidated waste
- Waste consolidation activities conducted under Health and Safety Plan consistent with OSHA 1910.120 requirements.

## 3.6 PASSIVE GAS CONTROL SYSTEM

Passive Landfill Gas Control design criteria/objectives are:

- Control lateral migration
- Prevent accumulation of landfill gas
- Collect gas from the entire area and depth of the landfill
- Comply with applicable air quality standards

## 3.7 COVER SYSTEM COMPONENTS

The following design criteria have been developed to meet design requirements and meet engineering practice standards.

Gas Venting/Foundation Layer

The foundation layer serves as a separation layer between the waste and the barrier layer. This permeable layer also must be vented to prevent accumulation of gas and accompanying uplift pressures to barrier layer. Design criteria for this layer are:

- Granular permeable soil materials with 12% or less fines, for gas venting
- Rounded particles no larger than 1-1/2 inch diameter, for FML foundation
- Compact to 90% of standard Proctor
- Proof roll to show absence of void spaces.

Flexible Membrane Liner

A FML barrier layer will be installed. Design criteria are use of Linear Low Density Poly Ethylene (LLDPE) geomembrane with minimum thickness of 40 mil. Textured or smooth LLDPE will be used depending on slope stability analysis. LLDPE was chosen because of its superior performance in landfill environments.

Drainage Layer

A geonet/geotextile composite will be used for the drain layer. This synthetic layer will consist of an HDPE geonet core, heat bonded on both sides with a non-woven geotextile. The drain layer will achieve a minimum transmissivity of $3x10^{-5}$ $m^2$/sec.

Cover Soil

Construct a layer of cover soil eighteen (18) inches thick between drain layer and vegetative top soil layer to protect the barrier layer from erosion. Design criteria for the cover soil layer are soil materials free of deleterious materials with no greater than six (6) inch particle size placed eighteen (18) inches thick over drain layer material.

Top Soil/Vegetative Layer

Construct a six (6) inch thick topsoil layer capable of sustaining vegetative growth. Topsoil design criterion are: more than 3% organic matter; silty clay loam soil with particle size less than three (3) inches; and sufficient plant nutrients to propagate and sustain vegetative growth.

The vegetative layer will be sealed with a seed mix that includes the native grass varieties as identified in the Pre-Design Studies Report (Woodward-Clyde, December 1996).

### 3.7.1 Stormwater and Erosion Controls

A run-on and run-off system will be installed that is capable of collecting and controlling water volume resulting from at least a 24-hour, 25-year storm event. The system shall be capable of preventing hazardous waste or its constituents from escaping into the soil, surface water bodies, groundwater, or sewer and drains.

Erosion will be limited to not more than 2 tons per acre per year.

Erosion control measures will be implemented, as necessary, to comply with the provisions of Act 347 which apply to cap construction activities.

## 3.8 FLOODPLAIN

No design criteria have been identified relating to floodplains since no remedial action construction activities are planned within a floodplain and hazardous wastes are not anticipated to be managed within a 100-year floodplain as designated in Figure 27 of the Final Remedial Investigation Report (WWES, 1994)

Some monitoring wells are located in the flood plain but will not affect flood plain characteristics. Should contingency action be implemented, Design Criteria will be developed to evaluate and eliminate, if appropriate, potential impacts to the flood plain.

## 3.9 WETLANDS

There has been no design criteria identified for wetlands as the remedial action will not impact any wetlands and there have been no wetlands identified within the remedial action area. All stormwater will be controlled on site with infiltration basins. Some wetland habitat contiguous to the North Branch of the Kalamazoo River exists. However, the remedial action will not impact this area that is across E. Erie Road. Should the contingency action be implemented, design criteria will be developed to mitigate potential impacts to nearby wetlands.

## 3.10 ENDANGERED SPECIES AND FAUNA

The Endangered Species Act (16 USC. 1531 et. seq. and 50 CFR Part 200 and Part 402 do not apply because no endangered or threatened species exist on the ASTL Site (Final Presumptive Remedy Feasibility Report, WWES, September, 1994).

4

This section presents the landfill design elements related to closure of the landfill based on the applicable or relevant and appropriate requirements (ARARs) and SOW requirements outlined in the previous section. An overview of each design element will be presented to establish a basis of design and depict the characteristics of the design components. The elements to be discussed are as follows:

- Area Drum Removal and Disposal
- Waste Movement and Site Grading
- Passive Landfill Gas Control
- Landfill Cover System
- Design Analysis
- Location of Construction Activities

## 4.1 AREA DRUM REMOVAL AND DISPOSAL

A confirmed fill area of buried drums is located on site. This element of the project must be addressed in the cover system grading plan and be given priority in the project construction schedule.

Consideration for the drum removal and disposal has been incorporated into the design in areas such as delineating the exclusion (work) zone area for excavation, providing a staging area for drum overpacking and outlining procedures and materials to be utilized in the removal, sampling, evaluation, overpacking, transport and treatment or disposal of the drums removed.

## 4.2 WASTE MOVEMENT AND SITE GRADING

As it currently exists, the landfill waste disposal area is relatively flat on the main part of the fill and has steep side embankments located on a majority of the edges. Some of the waste has been placed on properties adjacent to the landfill. Trees and surface debris litter a large portion of the site.

Prior to initiating any site grading activities, all metal debris will be removed from the landfill surface and staged for salvage or incorporated under the cap. The entire site will be stripped of existing surface vegetation and debris. Cut materials, which will include some surface waste materials, will be placed within proposed fill areas on the main fill area and compacted. Trees and shrubs will be processed through a chipper prior to placement. On-site soil material will be placed on top of the stripped material on an as needed basis for a working cover to discourage any fugitive transport of waste off-site.

In order to meet the minimum slope requirements set by the Michigan Department of Environmental Quality (MDEQ) Rules (discussed in Section 3 of this report) and to support positive stormwater drainage, fill must be placed on the landfill surface and graded. Moving the waste from the eastern property boundary toward the interior of the main fill providing a 100 foot buffer for site access and stormwater drainage will also create sufficient grading material to achieve four (4) percent minimum slopes. The slopes along all sides of the landfill will be graded to a maximum of 4 (horizontal) to 1 (vertical). A minimum of six (6) inches of soil cover material will be placed over all relocated waste upon completion of grading which will provide cover to reduce odors and discourage any transport of waste off-site.

Design grades for interior and perimeter stormwater drainage features range between 2 to 4 percent. These grades are controlled by existing site topography, outlet elevations and final landfill cover elevations.

Excavated material from proposed stormwater retention basins will be utilized for on-site soil borrow during the cover construction and coordinated with the perimeter stormwater drainage design to create retention/infiltration basins. This will eliminate any off-site discharge of the landfill stormwater runoff to surrounding roadside ditches and properties.

Final site grading will include a site access road in compliance with MDEQ Solid Waste Rules situated around the perimeter of the completed cap area. Access will also be provided to the crest of the cap for any future operations and maintenance activities. The access road will consist of a twelve (12) inch thick gravel layer twenty (20) feet wide placed on top of the cover soil layer. The perimeter road has a one (1) per cent cross grade to provide drainage from the gravel surface to the flowline and avoid ponding.

## 4.3 PASSIVE LANDFILL GAS CONTROL

The passive landfill gas control system for the site serves the purpose of the following items:

- Reduce gas (uplift) pressures under the FML cover system.
- Control vertical and horizontal migration of landfill gases from the landfill cover area.
- Vent gas to the atmosphere at levels which do not exceed a total cancer risk of $1\times10^{-6}$ at the site fenceline.

The passive gas collection and venting system are designed based on the design analysis as discussed in Section 4.5 of this report. The horizontal passive gas vent well design includes the following components:

- Perforated High Density Polyethylene (HDPE) pipe placed within a washed stone packed trench excavated into the waste a minimum of four (4) feet.
- Vertical vent risers connected to the horizontal passive vent wells located on crest of the landfill slope spaced approximately 190 feet apart from north to south across the site.

## 4.4 COVER SYSTEM

The final landfill cover system contains individual components that perform a specific function in the overall performance of the landfill cover. Some of the functions considered in the design of the cover system include the following:

- Vegetative support
- Erosion control

- Drainage
- Separation
- Frost protection
- Minimizing surface water infiltration
- FML protection

Layers included in the final cover system design are outlined in the following sections and are supported by proper engineering analysis and documentation as required. The cover system components are described in the following sections from the bottom up.

### 4.4.1 Gas Collection/Foundation Layer

The purpose of the twelve (12) inch thick gas collection foundation layer is to provide a buffer between the waste and the flexible membrane liner (FML) to prevent any objects located on the surface of the waste that may compromise the barrier material from coming into contact with the geosynthetic material. Soil material used for the construction of this layer will be an on-site sand material consisting of rounded rock particles less than one and a half (1-1/2) inches in diameter. The material will be placed in two (2), six (6) inch lifts and completed to a density that is a minimum of 90 per cent of the standard Proctor. The final surface will be graded and rolled to produce a smooth surface that will provide a good bedding surface for the FML to provide adequate interface contact between the geosynthetic and soil.

### 4.4.2 Flexible Membrane Liner (FML)

Located above the foundation layer, the FML serves as the impermeable barrier to hydraulic infiltration and vertical gas migration for the cover system. The material to be used for this component is a 40 mil Linear Low Density Polyethylene (LLDPE) membrane. All seams will be overlapped and bonded together by heat fusion. Quality control testing will encompass the verification of the seams and overall quality of the material used.

Smooth surfaced FML will be used in all areas where the subgrade slope is less than 6 (horizontal) to 1 (vertical). The area of the cover system where the subgrade slope is anticipated to exceed 6 to 1 will be at the tie in of the cover system to the perimeter slopes. This area requires a textured FML to ensure slope stability on the 4 (horizontal) to 1 (vertical) slope.

### 4.4.3 Cover Soil

The cover soil component of the overall cover system functions in accomplishing the minimum working protection required by MDEQ and geosynthetics manufacturers. This layer will be placed directly over the drain layer and will require an on-site soil material that is similar in composition to the foundation layer.

### 4.4.4 Topsoil/Vegetative Layer

Six (6) inches of topsoil will form the uppermost layer of the landfill cover system. This layer's primary function is to promote and sustain vegetative growth on the surface and consequently control wind and water erosion. Proper fertilization and seeding of the 6-inch layer will yield sufficient vegetative growth that in turn will stabilize the surface of the cover system to provide long-term erosion protection. Drainage features that exceed two (2) percent slopes utilize a temporary erosion control mat that will limit erosion prior to full vegetation development. Topsoil material will be obtained from an off-site borrow source.

### 4.4.5 Stormwater and Erosion Controls

Stormwater from precipitation on the landfill site currently drains onto adjacent properties and infiltrates or sheet flows into highway ditches. No interior or perimeter drainage has been established on the existing landfill site.

To control and direct stormwater on the landfill cover system, three (3) foot high berms will be utilized. They require a flap of FML to be welded on the landfill impermeable membrane FML at a minimum two (2) percent grade perpendicular to the slope of the landfill. This flap is used for a back stop along the berm alignment for subsurface stormwater flow through the cover soil along the top of the impermeable FML. Perforated collection piping encompassed in a gravel pack wrapped in filter geotextile is placed up-slope from the berm flowline. Discharge of the berm and subsurface drain pipe is into the stormwater retention/infiltration basin created on the landfill property. The design for the stormwater and erosion controls for the cover system are based on the calculations outlined in Section 4.5.4 of this report.

## 4.5 DESIGN ANALYSIS

Supporting calculations and analysis for the design were generated for several elements of the landfill closure. Design calculations and analysis were performed in the following areas and are provided in Appendix A:

- Slope/FML stability.
- FML anchor trench depth/runout length.
- Soil loss from cover system.
- Stormwater runoff.
- Hydrologic Evaluation of Landfill Performance (HELP).
- Passive landfill gas horizontal well spacing.

### 4.5.1 Slope/FML Stability

The landfill cover system specified in the ROD and in this design utilizes a FML that consists of a LLDPE material placed on a layer of sand and is covered by a geonet/geotextile composite and then cover soil and topsoil. When this layered cover system is placed on a slope, the interfaces between the various material layers are subjected to shearing forces as a result of gravitational forces that tend to pull the upper portion of the soil mass to a more nearly level surface. A stability analysis model of the design cover system on the proposed maximum landfill cover slope is necessary to ensure an adequate factor of safety against slope failure is present.

The slope stability analysis was performed for a 4 (horizontal) to 1 (vertical) slope angle and utilizing a textured FML surface. Manufacturer data for interface friction data between the geotextile surface of the overlying drainage net and the textured FML was used. The underlying gas collection/foundation layer used a interface friction angle with the FML similar to that of an Ottawa Sand (clean, medium grained sand). Both sets of data used for this key interface area are believed to be conservative. The soil layers above the FML have been modeled as unsaturated for this analysis based on the results of the HELP model results for a 25 year, 24 hour design storm. Saturated conditions for the soil and waste under the FML were assumed, but because of an assumed static level of moisture in these layers the seepage component was not calculated.

Results of the analysis indicate satisfactory factors of safety against slope failure. The range of these factors was between 1.7 and 2.3. A factor of safety of 1.0 or less would merit a re-design of the landfill cover system and/or slope configurations.

### 4.5.2 FML Anchor Trench Depth/Runout Length

Geomembrane (FML) covered landfill caps require the use of an anchor trench on the edges of the capped area to keep the geosynthetic in place. Tensile forces due to uplift from landfill gas pressures or from surcharge loading on the cover system are the components that cause the anchor trench to be a requirement in geosynthetic cover systems.

The anchor trench consists of an excavation that is made around the perimeter of the covered waste area to the required depth, laying the FML over the side and bottom of the trench and then backfilling soil over the FML to hold the material in place. The required depth of the trench is determined by considering all the forces and associated stresses that act upon the FML. A factor of safety is applied to the maximum tensile force the geosynthetic material can resist to provide accommodation for worst-case scenarios.

Utilizing a conservative factor of safety of 4.0, the results for the required anchor trench depth and runout length indicate the depth to be approximately 1.9 feet and the width to be 2.0 feet. This information will be reflected in the design drawings by the incorporation of an anchor trench configuration that is 2 feet deep by 2 feet wide.

### 4.5.3 Soil Loss From Cover System

To predict the performance of the designed cover system configuration and the landfill cap slopes, the soil loss due to erosion was modeled. This analysis estimates the amount of soil erosion by precipitation and stormwater runoff. The maximum allowed soil loss due to erosion is two (2) tons per acre of landfill surface.

The analysis completed for the soil loss performance of the landfill cover system included some assumptions as the exact soil types to be used for the cover system and final grading plan have not yet been determined. This led to conservative material and slope configurations that are reflected in the calculation provided in Appendix A. Ground cover conditions analyzed for the site included 80 percent and 95-100 percent surface cover scenarios; these cover scenarios are most applicable to post-construction and long term landfill cap conditions, respectively.

Results indicate the assumed worst case soil and slope configuration used for the analysis show the soil loss for the 80 percent ground cover and 95-100 percent ground cover conditions are less than the allowed maximum of two (2) tons acre/year.

### 4.5.4 Stormwater Runoff

Stormwater runoff for the project site has been designed to exceed requirements outlined in the MDEQ Act 641 Rules. Guidelines provided in the Rules, indicate the landfill cap stormwater drainage and site retention/infiltration basins must perform adequately to the 24 hour 25 year design storm event. The design storm used for the evaluation of the site utilized the 24 hour 100 year storm event to provide additional capacity to the diversion structures and retention/infiltration basins.

The final site grading plan and stormwater management plan were divided into subwatershed areas that were determined based on landfill slope directions, locations of stormwater berms, and flow directions of the berms. Four subwatersheds were derived in this process.

Eagle Point watershed analysis software was next utilized and it incorporated the Soil Conservation Service TR-55 model for generation of the unit hydrographs. A triangular unit hydrograph distribution was produced using a curve number (CN) of 74. This CN corresponds with a clay loam soil (topsoil) and a vegetative cover in good condition (75% grass cover or more). These unit hydrographs were then used to generate computed flood hydrographs for the respective subwatersheds and produced a volume of stormwater discharge based on the 24 hour 100 year storm event precipitation of 5.78 inches.

Results of the analysis indicate a total required storage for the project site for the modeled storm event of approximately five (5) acre-feet. The eastern basin for the site will receive stormwater from two of the subwatershed areas that will require a total of 2.8 acre-feet of retention for the modeled storm. Available retention (with 2 feet of freeboard) is approximately 6 acre-feet. The western basin has been sized in conjunction with the soil borrow needed for the landfill cap materials and will easily handle the 1.0 acre-feet required by one subwatershed draining into it. The runoff from the western sub-watershed will be sheet flow of the landfill cap.

### 4.5.5 Hydrologic Evaluation of Landfill Performance (HELP)

A computer-based analysis (Appendix A) was performed to predict the infiltration performance of the landfill cover system by taking into consideration the soil/material used in each layer. Meteorological data that is specific to the region of the site is synthetically fabricated by the HELP program for the number of years specified creating a well-rounded model that accounts for most elements of cover system hydrologic performance.

A twenty-five (25) year storm event was analyzed for the design cover system. FML pinhole densities and FML installation defects were assumed to be relative to good installation quality. It was believed that with proper site construction QA/QC with experienced inspection personnel that this quality could be easily achieved.

The HELP analysis for both precipitation events indicated no percolation/leakage through the FML layer. Average water head across the FML layer (based on peak daily values) shows less than one (1) inch of accumulation.

### 4.5.6 Passive Landfill Gas Horizontal Well Spacing

Calculations (Appendix A) were performed to model the flow length required to effectively collect and vent the landfill gas produced under the final cover system. The analysis was based on proven corrective gas flow mechanisms and Darcy's equation assuming laminar flow. Typical landfill parameters cited in several literature sources were substituted in the analysis as site specific information was not available in the previous investigative studies performed for the site. The flow length equation derived from Darcy's equation utilized the following input parameters:

- Refuse permeability.
- Depth ratio (saturated gas flow depth versus depth of refuse).
- Specific weight of landfill gas.
- Landfill gas production rate.
- Landfill gas pressure.
- Refuse density.
- Atmospheric pressure.

Results of the analysis provided a flow length of approximately 95 feet. Because landfill gas will flow to a horizontal vent well from both directions within the interior of the landfill, the spacing of the vent wells will be twice the gas flow length. This provides a spacing guideline for the horizontal vent wells in the interior of the landfill of 190 feet.

## 4.6 LOCATION OF CONSTRUCTION ACTIVITIES

Various areas of the site and adjacent properties will be utilized during the construction phase of the project. These areas must be considered during the design process with respect to preservation of completed areas and areas sensitive to equipment traffic after completion of a designed closure component. The areas that will be addressed in this section include three major areas of the landfill construction as follows:

- Contractor staging/material storage
- Landfill closure activities
- Material borrow sources

### 4.6.1 Contractor Staging/Material Storage

The contractor selected for the construction phase of the project will require mobilization of equipment and materials to the site for the landfill closure. An area is needed to store equipment and materials as well as provide an area for employee parking and field offices. The area that is to be used in this capacity is the south end of the site bordering Erie Road. This will allow for easy transport and drop off of materials and equipment to the site and provide easy access to the cap areas where the equipment and materials will be used. If needed, additional staging area on the north side of the site may be used. This would encompass the proposed material borrow area/stormwater infiltration basin.

### 4.6.2 Landfill Closure Activities

The landfill construction activities will encompass the entire 18 acre site from the initiation of the remedial action. This will begin with the stripping and grubbing of the landfill area and continue with waste relocation efforts, passive gas system installation, followed by cover system placement and establishment of all access and stormwater controls. Based on the site design, these activities are able to be coordinated to ensure an efficient and quality closure.

### 4.6.3 Material Borrow Sources

The design indicates one soil material borrow source for the site that will be utilized for construction of the landfill cover system. Excavation activities will be located on the northern section of the landfill property and can also be considered as part of the stormwater control system construction. Depending on the soil quantities needed for the final cover system and the amount available on the north end (as determined in the final design), borrow activities could carry over to the south end of the landfill along Erie Road.

5

## 5.1 DESIGN DRAWINGS

Design drawings for the remedial action outline several components of the project. The following is a list of drawings that have been developed for the preliminary design submittal:

| Drawing Number | Drawing Description |
|---|---|
| 1 | Location Maps and Drawing Index |
| 2 | Existing Site Conditions |
| 3 | Grading Plan |
| 4 | Cover System Sections and Details |
| 5 | Stormwater Control Plan |
| 6 | Stormwater Control Sections and Details |
| 7 | Passive Landfill Gas Control Plan |
| 8 | Passive Landfill Gas Control Sections and Details |
| 9 | Perimeter Fence and Access Road Plan and Details |
| 10 | Erosion Control Plan and Details |

The drawings listed above are attached to this report in Appendix E. Sheets 9-11 are reserved for further development of the design. Sections and details of the cover system and finished grade necessary for construction are detailed on these sheets.

## 5.2 TECHNICAL SPECIFICATIONS

Specifications (Appendix E) are required for the various landfill components of the remedial action implementation. The purpose of the specifications is to provide requirements to the contractor on quality, type and performance issues associated with the various contents of the work. The following is a list of sections to be included in the specifications developed for the final design of the project:

| Specification Section | Description |
|---|---|
| 01011 | Summary of Project |
| 01039 | Progress Meetings |
| 01300 | Submittals |
| 01400 | Quality Assurance and Quality Control |
| 01450 | Health and Safety |
| 02110 | Clearing, Stripping and Grubbing |
| 02211 | Waste Excavation and Handling |
| 02212 | Drum Removal and Disposal |
| 02215 | Site Preparation |
| 02220 | Earthwork |
| 02235 | Filter Fabric |
| 02240 | Drainage Net |
| 02270 | Slope Protection and Erosion Control |
| 02671 | Monitoring Well Abandonment |
| 02715 | HDPE Pipe |
| 02778 | Geomembrane |
| 02831 | Chain Link Fence Construction |
| 02936 | Seeding |

6

This section identifies the properties related to the Remedial Action, any deed restrictions that will be imposed on the properties following completion of construction, easements that will be needed for construction and environmental monitoring, and applicable state, county and local permits required.

## 6.1 INTRODUCTION

Future development including, but not limited to, on-site excavation, construction and drilling shall be prohibited. The prohibition is achieved by filing with the Calhoun County recorder the restrictive covenants included in Appendix E of the UAO.

## 6.2 DEED RESTRICTIONS

Institutional controls in the form of deed restrictions or a local ordinance shall be implemented. The deed restrictions will prohibit the installation of any groundwater well which draws drinking water from the area noted in Figure 4 of the ROD to contain 2 ug/l of arsenic or more.

All restrictions regarding future development of the landfill shall be considered permanent. U.S. EPA may advise lifting the restrictions on future groundwater drinking water well installation when the arsenic concentrations in the groundwater area described in Figure 4 of the ROD remain below the MCL for two years.

## 6.3 EASEMENTS

Easements for access to properties adjacent to the landfill property for the construction and post-closure monitoring phases will be needed. Reasons for the establishment of these easements is outlined in the following sections.

### 6.3.1 Environmental Monitoring

Groundwater monitoring wells are currently in place on properties surrounding the landfill site. Access to these wells for post-closure monitoring will require adequate access for sampling for all properties involved.

### 6.3.2 Construction

During the construction phase of the project, access will be needed to adjacent properties for a few reasons. One aspect involves the waste relocation from properties on the east side of the site. Foliage and soil will be removed in this process and slopes will need to be reconstructed.

The other aspect involves site construction equipment and material storage areas. This requirement will have to infringe on the current property boundaries as the landfill proper will be encompassed in waste relocation and grading activities for a majority of the construction period rendering it impossible for storage of equipment and materials on the site. There also will need to be space designated in this lay-down area for office trailers for the contractor, subcontractors and the site engineer. This activity may require the vegetation be removed and the ground surface graded level if needed.

## 6.4 PERMIT REQUIREMENTS

WCC contacted personnel at Calhoun County and MDEQ (air quality and surface water division) to establish specific local requirements for the construction of the project. The City of Albion was not contacted as the project location is outside city limits.

Calhoun County personnel indicated they would require a Erosion Control Permit for any project that would involve the disturbance of more than 1 acre of land or was conducted within 500 feet of a waterway. This permit would require the submission of an application with the final project plans attached for review by the county. The application will be completed by the contractor prior to the start of construction and the contractor will be held responsible for compliance with the permit conditions.

The air quality division of the MDEQ has several rules under Act 451 of 1994 that should be considered. Primarily, Rule 230 concerning Air Toxics from New and Modified Sources, would have to be met. The rule provides atmospheric discharge limits that must not be exceeded. These limits are based upon the same risk level as required by the SOW; therefore, the MDEQ concerns will be addressed if the SOW requirements are met.

7

## 7.1 CONTRACTING STRATEGY

The Group has taken a traditional (bid-build) construction contracting strategy into consideration at this time. This strategy will require approximately 60 days to complete contractor selection as the process involves the following tasks:

- Preparation of bid document.
- Client review.
- Revisions to bid document.
- Solicitation of construction bids.
- Contractor selection.
- Negotiation of construction contract.

After these items are addressed, a notice to proceed will be issued to the selected contractor and implementation of the Remedial Action will begin.

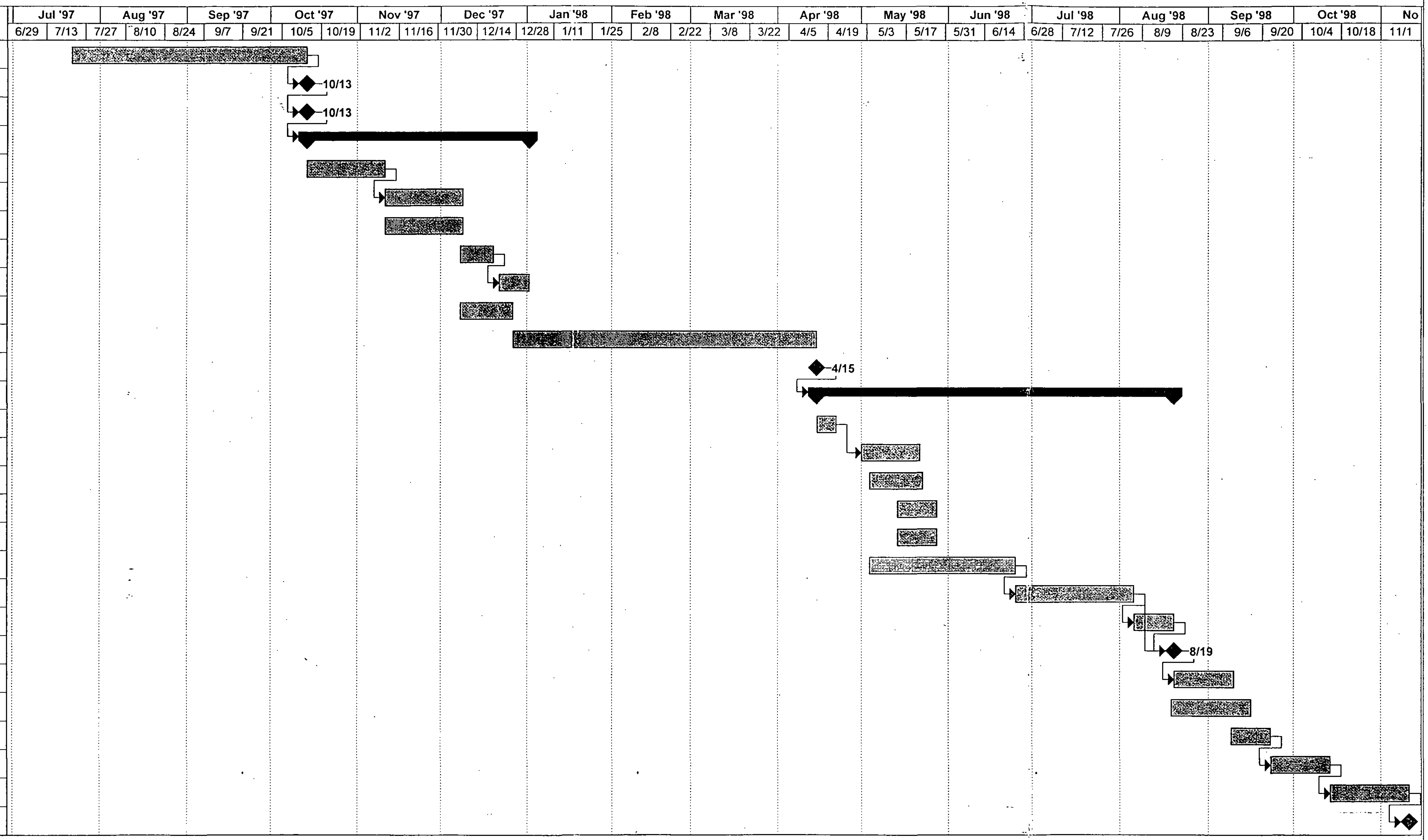
## 7.2 CONSTRUCTION SCHEDULE

A project schedule for the Remedial Action is submitted as Figure 7-1 which outlines the anticipated construction schedule. This schedule reflects the major components of the construction for the site and the milestones as outlined in the SOW. The schedule represents the scenario for the construction with the bid-build contracting strategy.

The selected Contractor will be required to submit a final construction schedule within 5 days of receiving the Notice to Proceed.

## FIGURE 7-1
## CONSTRUCTION SCHEDULE
## ALBION-SHERIDAN TOWNSHIP LANDFILL

| ID | Task Name |
|---|---|
| 1 | **Remedial Action Contracting** |
| 2 | Notice to Proceed |
| 3 | 1997 Construction Start |
| 4 | **1997 Remedial Action Construction** |
| 5 | Mobilization |
| 6 | Drum Removal |
| 7 | Stripping and Grubbing |
| 8 | Waste Removal/Grading |
| 9 | Passive Gas Vent Trenches |
| 10 | Foundation Layer |
| 11 | Winter Shutdown |
| 12 | 1998 Construction Start |
| 13 | **1998 Remedial Action Construction** |
| 14 | Regrading |
| 15 | FML/Drainage Net |
| 16 | Cover Soil Layer |
| 17 | Subsurface Drainage |
| 18 | Berm/Cap Access Road |
| 19 | Borrow/Infiltration |
| 20 | Topsoil/Seeding |
| 21 | Perimeter Fence |
| 22 | **Preliminary Construction Completion** |
| 23 | Pre-Final Inspection |
| 24 | Final O&M Plan |
| 25 | Pre-Final Inspection Report |
| 26 | Final Inspection |
| 27 | Final Construction Report |
| 28 | **Completion** |




Project: Albion-Sheridan Landfill

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

***NOTE: FINAL SCHEDULE WILL BE SUBMITTED BY THE SELECTED CONTRACTOR.

APPENDICES

A

APPENDIX A
FINAL REPORT

# DESIGN ANALYSIS CALCULATIONS ALBION TOWNSHIP LANDFILL CALHOUN COUNTY, MI

*Prepared for*
Cooper Industries
Houston Texas

and

Corning, Inc.
Corning, New York

August, 1997

Woodward-Clyde

38777 West Six Mile Road
Suite 200
Livonia, Michigan 48151
6E13045

# SLOPE STABILITY ANALYSIS

WOODWARD - CLYDE CONSULTANTS

Project Name: ALBION-SHERIDAN TOWNSHIP LANDFILL
Project Number: 6E13045
Calulations by: Robb Johnson
Date: April 22, 1997

Checked By: *[signature]*

Date: 4/25/97

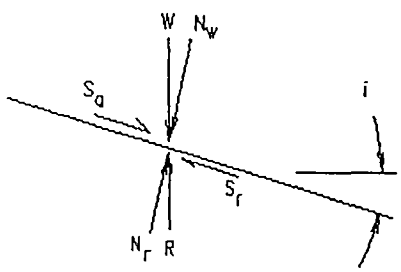
## SLOPE STABILITY OF A MULTILAYERED COVER SYSTEM

A mass of soil bounded by a sloping surface is subjected to shearing forces because gravitational forces will tend to pull the upper portion of the mass to more nearly level surface. As stated by Emil, the failure of cover soils with uniform depth is basically a surface raveling type of failure along the interface and can be analized by an infinite slope analysis to determine a safety factor.

Assumptions for the soil properties were based on project site observations made during the pre-design studies. Soil observed was a silty, medium-grained sand.

Assumptions for a textured 40 mil LLDPE liner friction angle were provided by GSE and were based on typical Ottowa Sand/FML direct shear testing data. Data on the overlying drainage net geotextile was provided by Fluid Systems and has been attached to this analysis.

To analyze the problem consider the forces acting on the interface of different soil layers:




Coefficients are as follows:

$x := 4.0$ Slope ratio, ex. 4:1

$i := \operatorname{atan}\left(\frac{1}{x}\right)$ $i = 14 \cdot \mathrm{deg}$

$\gamma_w := 62.4 \cdot \frac{lb}{ft^3}$ Unit weight of water, pcf

$a := 6 \cdot in$ Thickness of topsoil, inches

$b := 18 \cdot in$ Thickness of cover soil, inches

$c := 12 \cdot in$ Thickness of foundation layer, inches

$f_a := 25 \cdot deg$ Friction angle of topsoil, degrees

$\delta_{ab} := 25 \cdot deg$ Interface friction angle between topsoil and cover soil, deg.

$f_b := 25 \cdot deg$ Friction angle of cover soil, degrees

$\delta_{bfml} := 25 \cdot deg$ Interface friction angle between cover soil and Drainage Net, deg.

$\delta_{dnfml} := 30 \cdot deg$ Interface friction angle between the Drainage Net and FML, deg.

$\delta_{fmlc} := 25 \cdot deg$ Interface friction angle between FML and foundation layer, deg.

$f_c := 23 \cdot deg$ Friction angle of foundation layer, degrees

$\delta_{cw} := 23 \cdot deg$ Interface friction angle between foundation layer and waste, deg.

The topsoil and cover soil are modeled as being unsaturated above the relatively impervious FML and there is not any seepage parallel to the slope. This situation is possible based on the HELP Model output generated using the cover system profile shown above. HELP results indicated little head accumulation over the surface of the landfill for a 25 year 24 hour design storm which renders the seepage force component negligible. This efficient drainage of the landfill cover system is made possible throught the use of a synthetic drainage net placed on top of the entire surface of the FML. It is further assumed that that while the foundation layer is saturated, no seepage takes place due to a more static water level.

Each interface is analyzed:

Topsoil - Cover Soil

$$FS_{ab} := \frac{\tan(\delta_{ab})}{\tan(i)}$$

$FS_{ab} = 1.87$ ✓ Factor of safety of the Topsoil - Cover Soil interface

Cover Soil - FML

$$FS_{bfml} := \frac{\tan\left(\delta_{bfml}\right)}{\tan(i)}$$

$FS_{bfml} = 1.87$ ✓ **Factor of safety of the cover soil - Drainage Net interface**

**FML - Drainage Net**

$$FS_{fmlc} := \frac{\tan\left(\delta_{dnfml}\right)}{\tan(i)}$$

$FS_{fmlc} = 2.31$ ✓ **Factor of safety of the FML - Drainage Net interface**

**FML - Foundation Layer**

**Assume the water level in the saturated foundation layer is static and does not contribute to any seepage forces.**

$$FS_{fmlc} := \frac{\tan\left(\delta_{fmlc}\right)}{\tan(i)}$$

$FS_{fmlc} = 1.87$ ✓ Factor of safety of the FML - Foundation layer interface

Foundation Layer - Waste

Assume the water level in the saturated foundation layer and waste is static and does not contribute to any seepage forces.

$$FS_{cfml} := \frac{\tan(\delta_{cw})}{\tan(i)}$$

$FS_{cfml} = 1.7$ **Factor of safety of the Foundation Layer - Waste interface**

****** If FS is greater than 1.0 in all cases then slope should be stable against slumping failure, if FS is less than 1.0 then the liner system should be redesigned.**

**References:**


**Emil, T.B., "Slope Stability Issues in Waste Disposal," from presentation presented at Waste Geotechnics course, University of Wisconsin, January, 1991.**

**Lambe, T.W. and R.V. Whitman, "Soil Mechanics," John Wiley and Sons, New York, New York, 1969.**

**Koerner, Robert M.,"Designing With Geosynthetics," 3rd Edition, Prentice Hall, Englewood Cliffs, New Jersey, 1994, 1990, 1986.**

FSI
FLUID SYSTEMS

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800/346-9107
FAX: 630/898-1179

March 31, 1997

Rob Johnson
Woodward-Clyde
6465 Wayzata Blvd.
Minneapolis, MN 55426

Dear Rob:

Per request of Anita McKinley, the following will discuss ballpark friction values for geomembranes, both smooth and textured, against various materials. Remember that there are many variables involved in measuring friction angles. Each site is different and values can vary tremendously from project to project and site to site. Therefore, these values should be used as guidelines, not minimums. For each project, at least one test should be run, using site specific conditions, to verify the materials selected will meet project requirements.

**Ballpark friction angles:**
4:1 slopes are approximately 14°

| | smooth | textured |
|---|---|---|
| liner v. geotextile | 10 | 30 |
| liner v. clay | 16 | 29 |
| liner v. sand | 19 | 35 |
| liner v. net | 14 | 13 |

The range for these results, depending on site conditions can vary 30% or more. Also, remember the difference between peak and residual values.

A very rough rule of thumb is with slopes 3:1 and steeper, textured geomembranes and geocomposites are used and 4:1 and shallower can seriously consider smooth geomembranes and separate layers for the drainage materials. Again, each site is different and required materials and properties should be determined through the design.

If you have further questions, please feel free to call Anita or myself at 800-346-9107.

Very Truly Yours,

Larry D. Lydick
Technical Manager

$c$ = the cohesion of soil,

$\delta$ = the friction angle of soil to fabric, and

$\phi$ = the friction angle of soil.

Results from such a test setup by Martin, et al. [13], are presented in Table 2.6 for four geotextile types against three different cohesionless soils. Soil-to-fabric friction angles are given, as well as the fabric efficiency versus the soil friction angle by itself as per Equation 2.8. Here it is seen that most geotextiles can mobilize a high percentage of the soil's friction and can be used to advantage in situations requiring this feature. A review and compilation of a number of direct shear tests on various fabrics against different granular soils is given by Richards and Scott [14]. Another review by Williams and Houlihan [15] covers a wider range of soils, including some sands, silts, and mixed soils.

#### 2.2.3.11 Pullout (Anchorage) Tests

Geotextiles are often called upon to provide anchorage for many applications within the reinforcement function. Such anchorage usually has the fabric sandwiched between soil on each side of it. The resistance can be modeled in the laboratory using a pullout test, shown schematically in Figure 2.8b. The pullout resistance is obviously dependent on the normal force applied to the soil surrounding it, which mobilizes shear forces on both sides of the fabric.

Test results by Collios et al. [16] show a relationship of pullout test results to shear test results with some notable exceptions. If the soil particles are smaller than the fabric openings, efficiencies are higher; if not, they can be lower. In all cases, however, pullout test resistances are less than shear test resistances. This is due to the fact that the fabric is taut and exhibits large deformations. This in turn causes the soil particles to reorient themselves into a reduced-shear-strength situation at the soil-fabric interfaces, resulting in lower pullout resistance. The stress state mobilized in this test is a very complex one requiring additional research.

**TABLE 2.6** SOIL-TO-FABRIC FRICTION ANGLES AND EFFICIENCIES (IN PARENTHESES) IN COHESIONLESS SOIL

| Geotextile type | Manufacturer's designation | Concrete sand $\phi$ = 30 deg. | Rounded sand $\phi$ = 28 deg. | Silty sand $\phi$ = 26 deg. |
|---|---|---|---|---|
| Woven, monofilament | Polyfilter X | 26 deg. (84%) | — | — |
| Woven, silt film | 500X | 24 deg. (77%) | 24 deg. (84%) | 23 deg. (87%) |
| Nonwoven, melt-bonded | 3401 | 26 deg. (84%) | — | — |
| Nonwoven, needle-punched | CZ600 | 30 deg. (100%) | 26 deg. (92%) | 25 deg. (96%) |

Source: After Martin et al. [13]

F[...]IC U[...]D ON [...]AGE N[...]

# H.E.L.P. MODEL

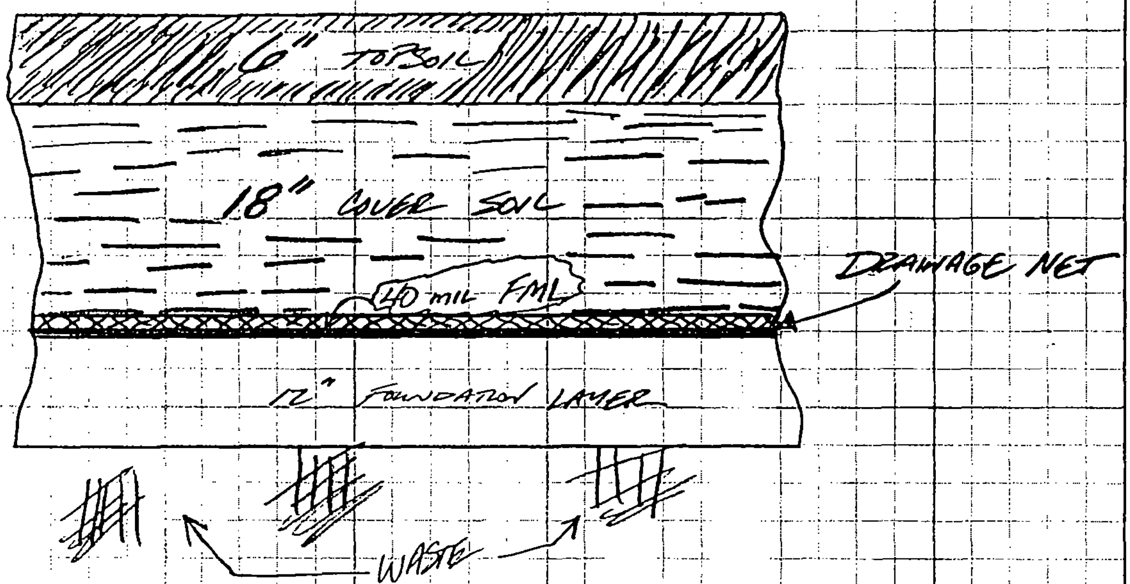
Subject ASTL HELP MODEL (25 YEAR) Project No. 6E3045

Task No. 230

By E. Johnson Checked By File No.

Date 4-21-97 Date Sheet 1 of 2

TYPICAL COVER SECTION:




SOIL TYPES USED:

TOPSOIL: SM (USCS CLASSIFICATION)

COVER SOIL: SC (USCS CLASSIFICATION)

HYDRAULIC CONDUCTIVITIES:

TOPSOIL: $1.2 \times 10^{-4}$ cm/SEC

COVER SOIL: $1.0 \times 10^{-5}$ cm/SEC

DRAINAGE NET: $3.3 \times 10^{1}$ cm/SEC

Subject ASTL HELP MODEL (25 YEAR)

Project No. 6E13045

Task No. 230

By R. Johnson

Checked By

File No.

Date 4-21-97

Date

Sheet 2 of 2

FML INPUT PARAMETERS:

FML PINHOLE DENSITY: 1.00 HOLES/ACRE

FML INSTALLATION DEFECTS: 4.00 HOLES/ACRE

FML PLACEMENT QUALITY: GOOD

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**               HELP MODEL VERSION 3.03  (31 DECEMBER 1994)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\ASTL1.D4
TEMPERATURE DATA FILE:       C:\HELP3\ASTL1.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\ASTL1.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\ASTL1.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\ASTL1.D10
OUTPUT DATA FILE:            C:\HELP3\ASTL1a.OUT


TIME:  17:23     DATE:   4/22/1997


******************************************************************************

     TITLE:  ALBION-SHERIDAN TOWNSHIP LANDFILL

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                       LAYER  1
                                       --------

                         TYPE 1 - VERTICAL PERCOLATION LAYER
                             MATERIAL TEXTURE NUMBER  10
           THICKNESS                    =        6.00   INCHES
           POROSITY                     =        0.3980 VOL/VOL
           FIELD CAPACITY               =        0.2440 VOL/VOL
           WILTING POINT                =        0.1360 VOL/VOL
           INITIAL SOIL WATER CONTENT   =        0.3168 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =    0.119999997000E-03 CM/SEC
         NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                    FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2
--------

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 5

| | | | |
|---|---|---|---|
| THICKNESS | = | 18.00 | INCHES |
| POROSITY | = | 0.4570 | VOL/VOL |
| FIELD CAPACITY | = | 0.1310 | VOL/VOL |
| WILTING POINT | = | 0.0580 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.1222 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.100000005000E-02 | CM/SEC |

LAYER 3
--------

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 34

| | | | |
|---|---|---|---|
| THICKNESS | = | 0.20 | INCHES |
| POROSITY | = | 0.8500 | VOL/VOL |
| FIELD CAPACITY | = | 0.0100 | VOL/VOL |
| WILTING POINT | = | 0.0050 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.0105 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 33.0000000000 | CM/SEC |
| SLOPE | = | 4.00 | PERCENT |
| DRAINAGE LENGTH | = | 200.0 | FEET |

LAYER 4
--------

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 36

| | | | |
|---|---|---|---|
| THICKNESS | = | 0.04 | INCHES |
| POROSITY | = | 0.0000 | VOL/VOL |
| FIELD CAPACITY | = | 0.0000 | VOL/VOL |
| WILTING POINT | = | 0.0000 | VOL/VOL |
| INITIAL SOIL WATER CONTENT | = | 0.0000 | VOL/VOL |
| EFFECTIVE SAT. HYD. COND. | = | 0.399999993000E-12 | CM/SEC |
| FML PINHOLE DENSITY | = | 1.00 | HOLES/ACRE |
| FML INSTALLATION DEFECTS | = | 4.00 | HOLES/ACRE |
| FML PLACEMENT QUALITY | = | 3 - GOOD | |

GENERAL DESIGN AND EVAPORATIVE ZONE DATA
----------------------------------------

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #10 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 200. FEET.

| | | | |
|---|---|---|---|
| SCS RUNOFF CURVE NUMBER | = | 86.20 | |
| FRACTION OF AREA ALLOWING RUNOFF | = | 100.0 | PERCENT |
| AREA PROJECTED ON HORIZONTAL PLANE | = | 1.000 | ACRES |
| EVAPORATIVE ZONE DEPTH | = | 20.0 | INCHES |
| INITIAL WATER IN EVAPORATIVE ZONE | = | 3.371 | INCHES |
| UPPER LIMIT OF EVAPORATIVE STORAGE | = | 8.786 | INCHES |
| LOWER LIMIT OF EVAPORATIVE STORAGE | = | 1.628 | INCHES |
| INITIAL SNOW WATER | = | 0.000 | INCHES |
| INITIAL WATER IN LAYER MATERIALS | = | 4.102 | INCHES |
| TOTAL INITIAL WATER | = | 4.102 | INCHES |
| TOTAL SUBSURFACE INFLOW | = | 0.00 | INCHES/YEAR |

## EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
E. LANSING MICHIGAN

| | | |
|---|---|---|
| MAXIMUM LEAF AREA INDEX | = | 3.50 |
| START OF GROWING SEASON (JULIAN DATE) | = | 123 |
| END OF GROWING SEASON (JULIAN DATE) | = | 283 |
| AVERAGE ANNUAL WIND SPEED | = | 10.10 MPH |
| AVERAGE 1ST QUARTER RELATIVE HUMIDITY | = | 77.00 % |
| AVERAGE 2ND QUARTER RELATIVE HUMIDITY | = | 69.00 % |
| AVERAGE 3RD QUARTER RELATIVE HUMIDITY | = | 75.00 % |
| AVERAGE 4TH QUARTER RELATIVE HUMIDITY | = | 80.00 % |

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 1.86 | 1.69 | 2.54 | 3.15 | 2.77 | 3.43 |
| 3.10 | 3.21 | 2.25 | 2.12 | 2.33 | 2.52 |

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR E. LANSING MICHIGAN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

| JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|
| 21.60 | 23.30 | 33.00 | 46.30 | 57.20 | 66.80 |
| 70.80 | 69.20 | 61.70 | 50.70 | 38.50 | 27.00 |

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR E. LANSING MICHIGAN

STATION LATITUDE = 42.60 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 25

| | JAN/JUL | FEB/AUG | MAR/SEP | APR/OCT | MAY/NOV | JUN/DEC |
|---|---|---|---|---|---|---|
| **PRECIPITATION** | | | | | | |
| TOTALS | 1.81 | 1.73 | 2.32 | 3.26 | 3.07 | 3.40 |
| | 3.00 | 2.93 | 2.55 | 1.65 | 2.46 | 2.78 |
| STD. DEVIATIONS | 0.69 | 0.82 | 1.02 | 1.22 | 1.17 | 1.47 |
| | 1.23 | 1.73 | 1.36 | 1.11 | 1.06 | 1.06 |
| **RUNOFF** | | | | | | |
| TOTALS | 0.930 | 1.168 | 1.384 | 0.816 | 0.071 | 0.058 |
| | 0.057 | 0.164 | 0.022 | 0.012 | 0.053 | 0.525 |
| STD. DEVIATIONS | 0.934 | 0.960 | 0.965 | 0.968 | 0.139 | 0.139 |
| | 0.125 | 0.300 | 0.058 | 0.054 | 0.098 | 0.653 |
| **EVAPOTRANSPIRATION** | | | | | | |
| TOTALS | 0.499 | 0.550 | 1.544 | 2.632 | 2.917 | 3.257 |
| | 2.740 | 2.130 | 2.140 | 1.150 | 0.773 | 0.464 |
| STD. DEVIATIONS | 0.099 | 0.167 | 0.313 | 0.577 | 1.040 | 1.038 |
| | 0.957 | 0.789 | 0.862 | 0.420 | 0.174 | 0.097 |
| **LATERAL DRAINAGE COLLECTED FROM LAYER 3** | | | | | | |
| TOTALS | 0.0652 | 0.0141 | 0.0265 | 0.3901 | 0.5209 | 0.4000 |
| | 0.2225 | 0.3878 | 0.2838 | 0.2940 | 0.7651 | 0.8489 |
| STD. DEVIATIONS | 0.0806 | 0.0053 | 0.0807 | 0.5594 | 0.3404 | 0.3372 |
| | 0.2852 | 0.5656 | 0.3067 | 0.4470 | 0.7725 | 0.8468 |
| **PERCOLATION/LEAKAGE THROUGH LAYER 4** | | | | | | |
| TOTALS | 0.0287 | 0.0143 | 0.0131 | 0.0397 | 0.0698 | 0.0633 |
| | 0.0479 | 0.0519 | 0.0487 | 0.0475 | 0.0694 | 0.0862 |
| STD. DEVIATIONS | 0.0126 | 0.0026 | 0.0062 | 0.0381 | 0.0306 | 0.0230 |
| | 0.0181 | 0.0306 | 0.0254 | 0.0346 | 0.0458 | 0.0482 |

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ACROSS LAYER 4

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGES | 0.0001 | 0.0000 | 0.0000 | 0.0003 | 0.0004 | 0.0004 |
| | 0.0002 | 0.0003 | 0.0003 | 0.0003 | 0.0007 | 0.0007 |
| STD. DEVIATIONS | 0.0001 | 0.0000 | 0.0001 | 0.0005 | 0.0003 | 0.0003 |
| | 0.0002 | 0.0005 | 0.0003 | 0.0004 | 0.0007 | 0.0007 |

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 25

| | INCHES | CU. FEET | PERCENT |
|---|---|---|---|
| PRECIPITATION | 30.97 ( 3.587) | 112415.3 | 100.00 |
| RUNOFF | 5.260 ( 1.8384) | 19092.13 | 16.984 |
| EVAPOTRANSPIRATION | 20.797 ( 1.7317) | 75494.02 | 67.156 |
| LATERAL DRAINAGE COLLECTED FROM LAYER 3 | 4.21883 ( 1.99099) | 15314.345 | 13.62301 |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.58043 ( 0.12781) | 2106.949 | 1.87425 |
| AVERAGE HEAD ACROSS TOP OF LAYER 4 | 0.000 ( 0.000) | | |
| CHANGE IN WATER STORAGE | 0.112 ( 1.2172) | 407.85 | 0.363 |

***********************************************************************************

******************************************************************************

PEAK DAILY VALUES FOR YEARS 1 THROUGH 25

| | (INCHES) | (CU. FT.) |
|---|---|---|
| PRECIPITATION | 2.92 | 10599.601 |
| RUNOFF | 3.075 | 11164.0381 |
| DRAINAGE COLLECTED FROM LAYER 3 | 1.06775 | 3875.93457 |
| PERCOLATION/LEAKAGE THROUGH LAYER 4 | 0.024162 | 87.70780 |
| AVERAGE HEAD ACROSS LAYER 4 | 0.029 | |
| SNOW WATER | 4.12 | 14965.1523 |

| | |
|---|---|
| MAXIMUM VEG. SOIL WATER (VOL/VOL) | 0.2792 |
| MINIMUM VEG. SOIL WATER (VOL/VOL) | 0.0631 |

******************************************************************************

$T_{allow} := \sigma_{allow} \cdot t$ the maximum allowable force

$F_U := 0 \cdot \frac{lb}{in}$ the friction force above the geomembrane (assumed to be negligible, since the cover soil will probably move along with the liner as it deforms)

$d_{cs} := 24 \cdot in$ the depth of the cover soil

$\gamma_{cs} := 125 \cdot \frac{lb}{ft^3}$ the unit weight of the cover soil

$q := d_{cs} \cdot \gamma_{cs}$ the surcharge pressure

$\delta := 30 \cdot deg$ the friction angle between the geomembrane and the soil

$L_{RO} := 2.0 \cdot ft$ the length of runout

$F_L := q \cdot \tan(\delta) \cdot L_{RO}$ the friction force below the geomembrane

$\gamma_{bs} := 125 \cdot \frac{lb}{ft^3}$ the unit weight of backfill soil

$H_{ave} := 2.0 \cdot ft$ the average depth of the anchor trench

$z := 2$ the resisting force acts on both sides of the anchor trench geomembrane

$\phi := 25 \cdot deg$ the angle of shearing resistance of the backfill soil

$K_O := 1 - \sin(\phi)$

$a := z \cdot K_O \cdot H_{ave} \cdot \gamma_{bs} \cdot \tan(\delta)$ the lateral stress ratio at rest

$$d_t := \frac{T_{allow} - F_U - F_L}{a}$$

$d_t = 1.9 \cdot ft$ **Depth of Anchor Trench**

*The depth of the anchor trench should be no more than dt, this will allow for failure of the anchor trench by pullout before tearing failure of the geomembrane.

References:

Bagchi, A., 1990, "Design, Construction, and Monitoring of Sanitary Landfill," John Wiley and Sons.

Koerner, R.M., 1990, "Designing with Geosynthetics, 2nd Ed.," Prentice Hall, Englewood, New Jersey.

Lambe, T.W. and R.V. Whitman, 1969, "Soil Mechanics," John Wiley and Sons.

U.S. EPA, 1992, "Draft Technical Manual for Solid Waste Disposal Facility Criteria," 40 CFR Part 258.

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FINAL WATER STORAGE AT END OF YEAR 25

| LAYER | (INCHES) | (VOL/VOL) |
|---|---|---|
| 1 | 1.4158 | 0.2360 |
| 2 | 2.4294 | 0.1350 |
| 3 | 0.0020 | 0.0102 |
| 4 | 0.0000 | 0.0000 |
| SNOW WATER | 0.000 | |

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United States
Environmental Protection
Agency

Office of Research and
Development
Washington DC 20460

EPA/600/R-94/168a
September 1994

EPA

# The Hydrologic Evaluation of Landfill Performance (HELP) Model

## User's Guide for Version 3

the geomembrane. The program has different equations for three ranges of saturated hydraulic conductivity: greater than or equal to 0.1 cm/sec; less than 0.1 and greater than or equal to 0.0001 cm/sec; and less than 0.0001 cm/sec.

1. *Perfect*: Assumes perfect contact between geomembrane and adjacent soil that limits drainage rate (no gap, "sprayed-on" seal between membrane and soil formed in place).

2. *Excellent*: Assumes exceptional contact between geomembrane and adjacent soil that limits drainage rate (typically achievable only in the lab or small field lysimeters).

3. *Good*: Assumes good field installation with well-prepared, smooth soil surface and geomembrane wrinkle control to insure good contact between geomembrane and adjacent soil that limits drainage rate.

4. *Poor*: Assumes poor field installation with a less well-prepared soil surface and/or geomembrane wrinkling providing poor contact between geomembrane and adjacent soil that limits drainage rate, resulting in a larger gap for spreading and greater leakage.

5. *Worst Case*: Assumes that contact between geomembrane and adjacent soil does not limit drainage rate, resulting in a leakage rate controlled only by the hole.

6. *Geotextile separating geomembrane liner and drainage limiting soil*: Assumes leakage spreading and rate is controlled by the in-plane transmissivity of the geotextile separating the geomembrane and the adjacent soil layer that would have otherwise limited the drainage. This quality would not normally be used with a geosynthetic clay liner (GCL) as the controlling soil layer. Upon wetting, the bentonite swells and extrudes into the geotextile, filling its voids and reducing its transmissivity below the point where it can contribute significantly to spreading of leakage. GCL's, when properly placed, tend to have intimate contact with the geomembrane (Harpur et al., 1993).

## 3.7 SITE CHARACTERISTICS

The user must also supply a value of the Soil Conservation Service (SCS) runoff curve number for Antecedent Moisture Condition II (AMC-II) or provide information so that a curve number can be computed. Unlike Version 2 of the HELP model, Version 3 accounts for surface slope effects on curve number and runoff. In Version 3 of the HELP model, there are three different options by which a curve number can be obtained.

1. A curve number defined by the user

*Pinhole Density*: the number of defects (diameter of hole equal to or smaller than the geomembrane thickness; hole estimated as 1 mm in diameter) in a given area generally resulting from manufacturing flaws such as polymerization deficiencies.

*Installation Defect Density*: the number of defects (diameter of hole larger than the geomembrane thickness; hole estimated as 1 $cm^2$ in area) per acre resulting primarily from seaming faults and punctures during installation.

*Geotextile Transmissivity*: the product of the in-plane saturated hydraulic conductivity and thickness of the geotextile.

The density of pinholes and installation defects is a subject of speculation. Ideally, geomembranes would not have any defects. If any were known to exist during construction, the defects would be repaired. However, geomembranes are known to leak and therefore reasonably conservative estimates of the defect densities should be specified to determine the maximum probable leakage quantities.

The density of defects has been measured at a number of landfills and other facilities and reported in the literature. These findings provide guidance for estimating the defect densities. Typical geomembranes may have about 0.5 to 1 pinholes per acre (1 to 2 pinholes per hectare) from manufacturing defects. The density of installation defects is a function of the quality of installation, testing, materials, surface preparation, equipment, and QA/QC program. Representative installation defect densities as a function of the quality of installation are given below for landfills being built today with the state-of-the-art in materials, equipment and QA/QC. In the last column the frequency of achieving a particular installation quality is given. The estimates are based on limited data but are characteristic of the recommendations provided in the literature.

| Installation Quality | Defect Density (number per acre) | Frequency (percent) |
|---|---|---|
| Excellent | Up to 1 | 10 |
| Good | 1 to 4 | 40 |
| Fair | 4 to 10 | 40 |
| Poor | 10 to 20* | 10 |

* Higher defect densities have been reported for older landfills with poor installation operations and materials; however, these high densities are not characteristic of modern practice.

The user must also enter the placement quality of the geomembrane liner if pinholes or installation defects are reported. There are six different possible entries for the geomembrane liner placement quality. The program selects which equation will be used to compute the geomembrane based on the placement quality specified and the saturated hydraulic conductivity of the lower permeability soil (drainage limiting soil) adjacent to

# ANCHOR TRENCH AND RUNOUT LENGTH ANALYSIS

WOODWARD-CLYDE CONSULTANTS

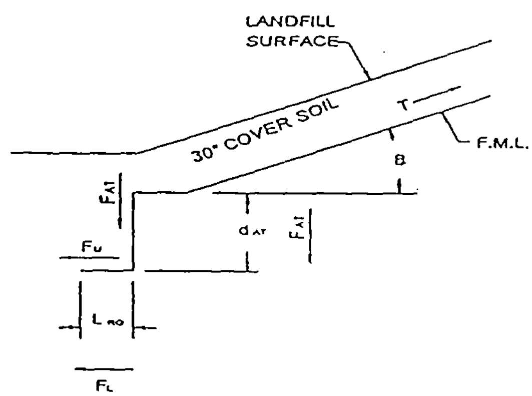
Project Name: ALBION-SHERIDAN TOWNSHIP LANDFILL
Project Number: 6E13045
Calculations by: Robb Johnson
Date: December 18, 1996

Checked by: John Kittelson
Date: December 18, 1996

## ANCHOR TRENCH DEPTH AND RUNOUT LENGTH DESIGN

Geomembrane covered landfill caps and cells often require the use of an anchor trench to keep the geomembrane from becoming mobile after installation. Equations developed by Koerner (1990) were used to calculate depth of the anchor trench and runout length required.

ANCHOR TRENCH CONFIGURATION




Coefficients as follows:

$\sigma_{yield} := 5000 \cdot \frac{lb}{in^2}$ the geomembrane stress at break

$FS := 4.0$ the geomembrane factor of safety

$\sigma_{allow} := \frac{\sigma_{yield}}{FS}$ the allowable geomembrane stress

$\sigma_{allow} = 1250 \cdot \frac{lb}{in^2}$

$mil := \frac{1}{1000} \cdot in$

$t \quad 40 \cdot mil$ the geomembrane thickness

# SOIL LOSS ANALYSIS

Subject ALBION - SHERIDAN LANDFILL Project No. 6E13045

By R. Johnson Checked By Task No. 210

File No.

Date 1-6-97 Date Sheet 1/2

$A = R \times K \times LS \times C \times P$

WHERE:

$A$ = AVERAGE ANNUAL SOIL LOSS (TONS/ACRE)
$R$ = RAINFALL FACTOR
$K$ = SOIL ERODIBILITY FACTOR
$LS$ = SLOPE LENGTH & STEEPNESS FACTOR
$C$ = COVER/MANAGEMENT FACTOR
$P$ = EROSION CONTROL PRACTICE FACTOR.

$R$ (RAINFALL FACTOR) FOR CALHOUN CO., MICHIGAN

$R = 120$ (SHEET 4 OF 7 USDA TECHNICAL GUIDE)

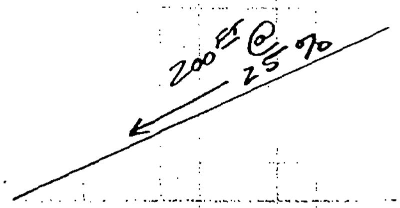
$K$ (SOIL ERODIBILITY)

BECAUSE SOIL TYPE IS UNKNOWN FOR THE LANDFILL CAP ASSUME A WORST CASE MATERIAL (MIAMI) SOIL FROM TABLE I-2 (SHEET 5 OF 7 USDA TECHNICAL GUIDE).

$K = 0.32$

$LS$ (SLOPE FACTOR)

→ ASSUME WORST CASE FOR SLOPE LENGTH & DEGREE




→ FROM WDOE SOLID WASTE FIGURE 4D.3:

$LS = 8.50$

Subject ALBION - SHERIDAN LANDFILL | Project No. 6E13045
By R. Johnson | Checked By | Task No. 210
File No.
Date 1-6-97 | Date | Sheet 2/2

CP (CONTROL PRACTICE)

CP = 0.006 (ESTABLISHED GRASS, GROUND COVER 80%)

SOLVING FOR A:

$A = (R)(K)(LS)(CP)$

$A = (120)(0.32)(8.5)(0.006)$

$A = 1.95 \leq$ EPA MAX OF 2 TONS/ACRE

→ THIS GROUND COVER (80%) STATUS WOULD CORRESPOND TO THE FIRST FEW MONTHS OF POST CONSTRUCTION PRIOR TO FULL VEGETATION.

CP = 0.003 (ESTABLISHED GRASS, GROUND COVER 95%-100%)

SOLVING FOR A:

$A = (R)(K)(LS)(CP)$

$A = (120)(0.32)(8.5)(0.003)$

$A = 0.979 <$ EPA MAX OF 2 TONS/ACRE

→ THIS GROUND COVER (95-100%) CORRESPONDS TO POST CONSTRUCTION AFTER FULL VEGETATION.

TEMPORARY SEDIMENT BASIN IN DEVELOPING AREAS

APPENDIX I

# USE OF THE UNIVERSAL SOIL LOSS EQUATION IN DEVELOPING AREAS

The following procedure for soil loss computations is an adaptation of the Universal Soil Loss Equation as presented in Agricultural Handbook No. 282, Rainfall-Erosion Losses From Cropland East Of The Rocky Mountains. A more precise computation can be made by using the full procedures given in this publication.

To predict soil losses in developing areas the simplified form of the equation is:

A = RCKLS

A - is the computed soil loss per acre per year in tons. This quantity may be converted to cubic yards by using the conversion factors found in Table I-1. All soil loss computations will be made using full years as the unit of time - that is, 1 year, 2 years, etc. - unless the more detailed procedures of Agricultural Handbook No. 282 are used.

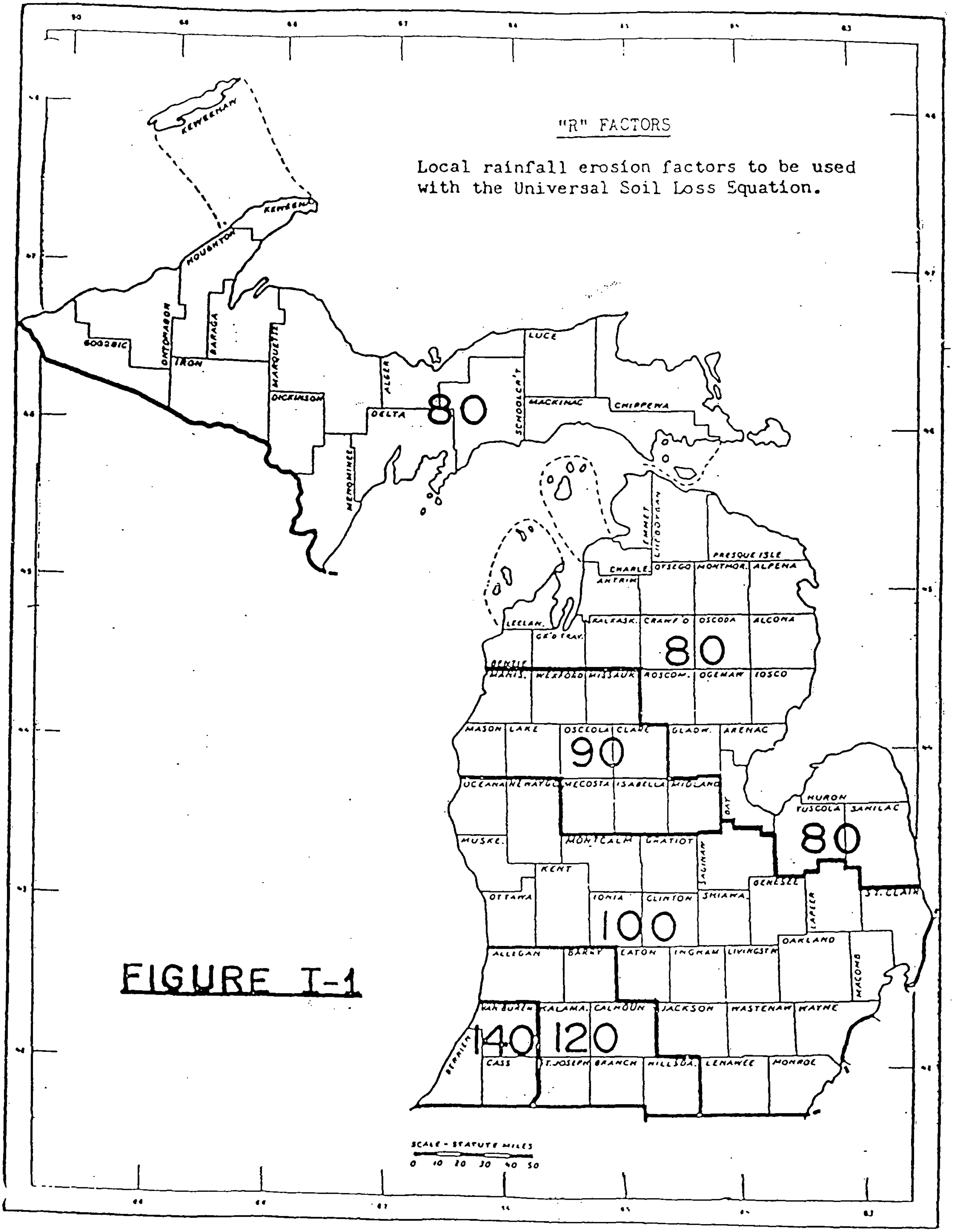
R - is the average annual rainfall erosion index which is a measure of the erosive force of rainfall. The "R" value for urban areas is the same as that for agricultural lands and should be used in predicting annual soil losses on construction sites. Figure I-1 gives "R" values for each county in Michigan.

C - is the ratio of soil loss from land cropped under specified conditions to the corresponding loss from tilled, continuous fallow. For developing areas the following three values will represent conditions in most cases:

| | |
|---|---|
| Well established grass or grass-legume cover | C=0.006 |
| Weeds and wild grass cover | C=0.120 |
| Fallow or disturbed area | C=1.000 |

K - is the soil erodibility factor. On construction sites, substrata materials are often exposed to water erosion so that appropriate "K" values must be used. Table I-2 give "K" values for both agricultural soils and also for the substrata material.

Limited research data show that infiltration rates and erosion losses from compacted fills do not differ greatly from those on "cuts," when slopes and surface materials are the same. Loose fills may lose less soil and water than compacted fills. Since




"R" FACTORS

Local rainfall erosion factors to be used with the Universal Soil Loss Equation.

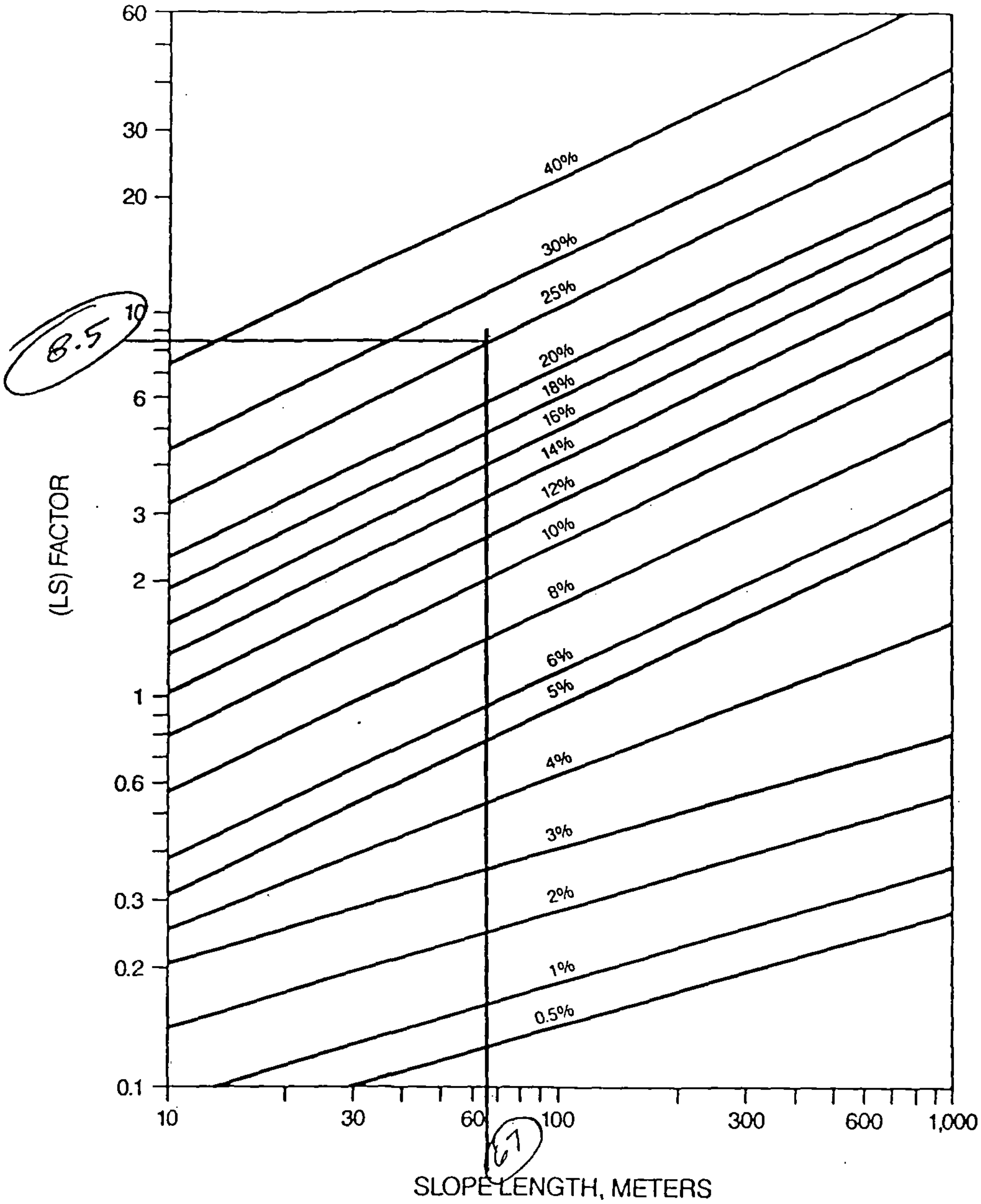
FIGURE I-1

TABLE I - 2

SOIL ERODIBILITY "K" VALUES 1/

| Soil Series | Undisturbed Material 2/ | Disturbed Material 2/ |
|---|---|---|
| Blount | .43 | .22 |
| Boyer | .24 | .20 |
| Bronson | .24 | .24 |
| Celina | .37 | .28 |
| Coloma | .17 | .24 |
| Fox | .32 | .32 |
| Hillsdale | .32 | .32 |
| Kalamazoo | .32 | .32 |
| Kibbie | .37 | .50 |
| Lapeer | .28 | .32 |
| Metea | .28 | .30 |
| Miami | .37 | .37 |
| Morley | .43 | .24 |
| Oakville | .17 | .17 |
| Oshtemo | .24 | .30 |
| Ottawa | .17 | .17 |
| Owosso | .28 | .37 |
| Perrin | .24 | .32 |
| Plainfield | .17 | .17 |
| Sisson | .37 | .50 |
| Spinks | .17 | .24 |

1/ Most of the somewhat poorly drained soils and alluvial soils are omitted from this table since they do not normally occur on slopes where erosion would be a problem.




WDOE Solid Waste

Landfill Design Manual

Adapted From: Novotny and Chesters, 1981

Figure 4D.3

Length-Slope Factor (LS) for Different Slopes

# PASSIVE GAS VENT WELL SPACING ANALYSIS

Subject: ASTL – PASSIVE GAS VENT PIPE SPACING | Project No. 6E15045
By: RJ | Checked By: | Task No. 210
Date: 12-17-96 | Date: | File No.:
Sheet 1/3

PROBLEM: DETERMINE THE PROPER SPACING FOR THE HORIZONTAL LANDFILL GAS PASSIVE VENT WELLS.

BASED ON CONVECTIVE GAS FLOW MECHANISMS AND DARCY'S EQUATION (LAMINAR FLOW ASSUMED):

$$L^2 = \frac{[K * (m_1/m_2) * (1/SW) * (P_2 - P_1) * (8760)]}{R * D}$$

WHERE:

$L$ = FLOW LENGTH (FT)
$m_1$ = DEPTH OF SATURATED GAS FLOW (FT)
$m_2$ = DEPTH OF REFUSE (FT)
$K$ = REFUSE PERMEABILITY (FT/HR)
$SW$ = SPECIFIC WEIGHT OF LANDFILL GAS ($lbf/FT^3$)
$P_2$ = LANDFILL GAS PRESSURE ($lbf/FT^2$)
$P_1$ = ATMOSPHERIC PRESSURE ($lbf/FT^2$)
8760 = TIME CONVERSION (HR/YR)
$R$ = GAS PRODUCTION RATE ($FT^3$/YR-lbm)
$D$ = REFUSE DENSITY ($lbm/FT^3$)

TYPICAL INPUT VALUES:

REFUSE PERMEABILITY (K) = $7.44 \times 10^{-3}$ FT/HR

DEPTH RATIO ($m_1/m_2$) = 1.0 (ASSUMED FOR SHALLOW LANDFILLS)

SPECIFIC WEIGHT (SW) = $7.89 \times 10^{-2}$ $lbf/FT^3$

GAS PRESSURE ($P_2$) = 15.67 $lb/FT^2$ (GUAGE)

GAS PRODUCTION RATE (R) = 0.04 $FT^3$/YR-lb

REFUSE DENSITY (D) = 37 $lb/FT^3$ (1000 $lb/YD^3$)

ATMOSPHERIC PRESSURE ($P_1$) = 14.696 $lb/IN^2$ (2116.224 $lb/FT^2$)

Subject ASTL – PASSIVE GAS VENT PIPE SPACING

Project No. 6E13045

By RJ

Checked By

Task No. 210

File No.

Date 12-17-96

Date

Sheet 2/3

→ CONVERT LANDFILL PRESSURE (GUAGE) TO AN ABSOLUTE PRESSURE:

$$P_2 = P_{GUAGE} + P_{ATM} = P_{ABSOLUTE}$$

$$\therefore P_2 = 15.67 \text{ lb/FT}^2 + 2116.224 \text{ lb/FT}^2 = \underline{2131.894 \text{ lb/FT}^2}$$

→ SUBSTITUTING INTO THE ORIGINAL FLOW LENGTH EQUATION DEFINED ON SHEET 1:

$$L^2 = \frac{[K * (m_1/m_2) * (1/S_W) * (P_2 - P_1) * (8760)]}{R * D}$$

$$L^2 = \frac{[(7.44 \times 10^{-3}) * (1.0) * (1/4.89 \times 10^{-2}) * (2131.894 - 2116.224) * (8760)]}{(0.04) * (37)}$$

$$L^2 = 8745.96$$

$$\underline{L = 93.5 \text{ FT}}$$ (FLOW LENGTH DEFINED)

→ BECAUSE GAS WILL FLOW TO A TRENCH FROM BOTH DIRECTIONS WITHIN THE LANDFILL, THE SPACING OF TRENCHES WILL BE TWICE THE GAS FLOW LENGTH AS SHOWN BELOW:

$$S = 2(L)$$

WHERE: S = TRENCH SPACING (FT)

$$\therefore S = (2)(L)$$

$$S = 2(93.5)$$

$$\underline{\underline{S = 187 \text{ FT} \approx 190 \text{ FT}}}$$

Subject ASTL - PASSIVE GAS VENT PIPE SPACING

Project No. 6E13045

By RJ

Checked By

Task No. 210

File No.

Date 12-17-96

Date

Sheet 3/3

REFERENCES: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SCHUMACHER, M.M. (ED.). 1983. "LANDFILL METHANE RECOVERY." PARK RIDGE, NJ: NOYES DATA CORP.

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## APPENDIX 4G

## SPACING PASSIVE HORIZONTAL GAS COLLECTION PIPES

### 4G.1 INTRODUCTION

The control of methane gas migration to below dangerous levels should be the goal of any gas control system. The Washington State Department of Ecology's Minimum Functional Standards for solid waste handling (WAC 173-304-460) require methane concentrations less than the lower explosive limits (5% by volume) at the landfill property boundary or beyond and less than 100 parts per million methane by volume in off-site structures. Therefore, upon construction or closure of a landfill, facilities to reduce methane migration or provide for ready collection of methane within the landfill may be required.

### 4G.2 FLOW BY DIFFUSION

Methane moves by way of diffusive (concentration gradient) and convective (pressure gradient) mechanisms. Diffusive flow of gas is in the direction of decreasing concentration. Diffusion within a landfill may occur by ordinary diffusion, Knudsen diffusion, and surface migration (Schumacher 1983). While diffusion can be an important element in lateral migration of methane, its effect is minimal where naturally occurring pressures are high within the landfill or when an induced exhaust system is used to increase the landfill pressure gradient (Moore 1979, Schumacher 1983).

### 4G.3 FLOW BY CONVECTION

In systems where a natural or induced pressure gradient occurs, convective mechanisms will be the primary means of gas flow (Schumacher, 1983). Therefore, the method of removing methane from a landfill is by producing a pressure/concentration sink to which the gas will flow. Darcy's Law has been used to characterize the flow of gas through the refuse (Findikakis and Leckie 1979). Using Darcy's equation and the assumption that as methane is produced it is simultaneously removed by convective mechanisms, the following mathematical expressions were derived:

Darcy's Equation:

$$q = K*m_1*(1/s.w.)*((P_2-P_1)/L) \qquad (4G\text{-}1)$$

where:
$q$ = gas flow per unit width ($ft^2/hr$)
$K$ = refuse permeability (ft/hr)
$m_1$ = depth of saturated gas flow (ft)
$s.w.$ = specific weight of landfill gas ($lbf/ft^3$)
$P_1$ = atmospheric pressure ($lbf/ft^2$)

$P^2$ = landfill gas pressure ($lbf/ft^2$)
L = flow length (ft)

The total flow out of a given width of refuse is:

$$Q = K*m_1*(1/s.w.)*((P2-P_1)/L)*w \quad (4G-2)$$

where: Q = gas flow ($ft^3/hr$),
w = width of flow (ft).

Rearranging terms and isolating flow length on the left:

$$L = K*m_1*w*(1/s.w.)*((P_2/P_1)/Q) \quad (4G-3)$$

Assuming gas flow is equal to gas production, the following equation applies:

$$Q = R*(L*w*m_2)*D/(8760) \quad (4G-4)$$

where: R = gas production rate ($ft^3/yr-lbm$),
$m_2$ = depth of refuse (ft),
D = refuse density ($lbm/ft^3$),
8760 = time conversion (hr/yr).

Substituting Equation 4G-4 into Equation 4G-3 and combining flow length terms on the left:

$$L^2 = (K*(m_1/m_2)*(1/s.w.)*(P_2-P_1)*(8760))/R*D \quad (4G-5)$$

Because gas will flow to a trench from both directions within the landfill, the spacing of trenches will be twice the gas flow length or:

$$S = 2(L) \quad (4G-6)$$

where: S = trench spacing (ft).

Darcy's equation has been used to describe the flow of gas in several landfill gas models. However, the equation applies only to laminar flow, not to turbulent flow (Schumacher, 1983). In most systems, especially in a passive system without an induced pressure gradient, it has been shown that flow is indeed laminar.

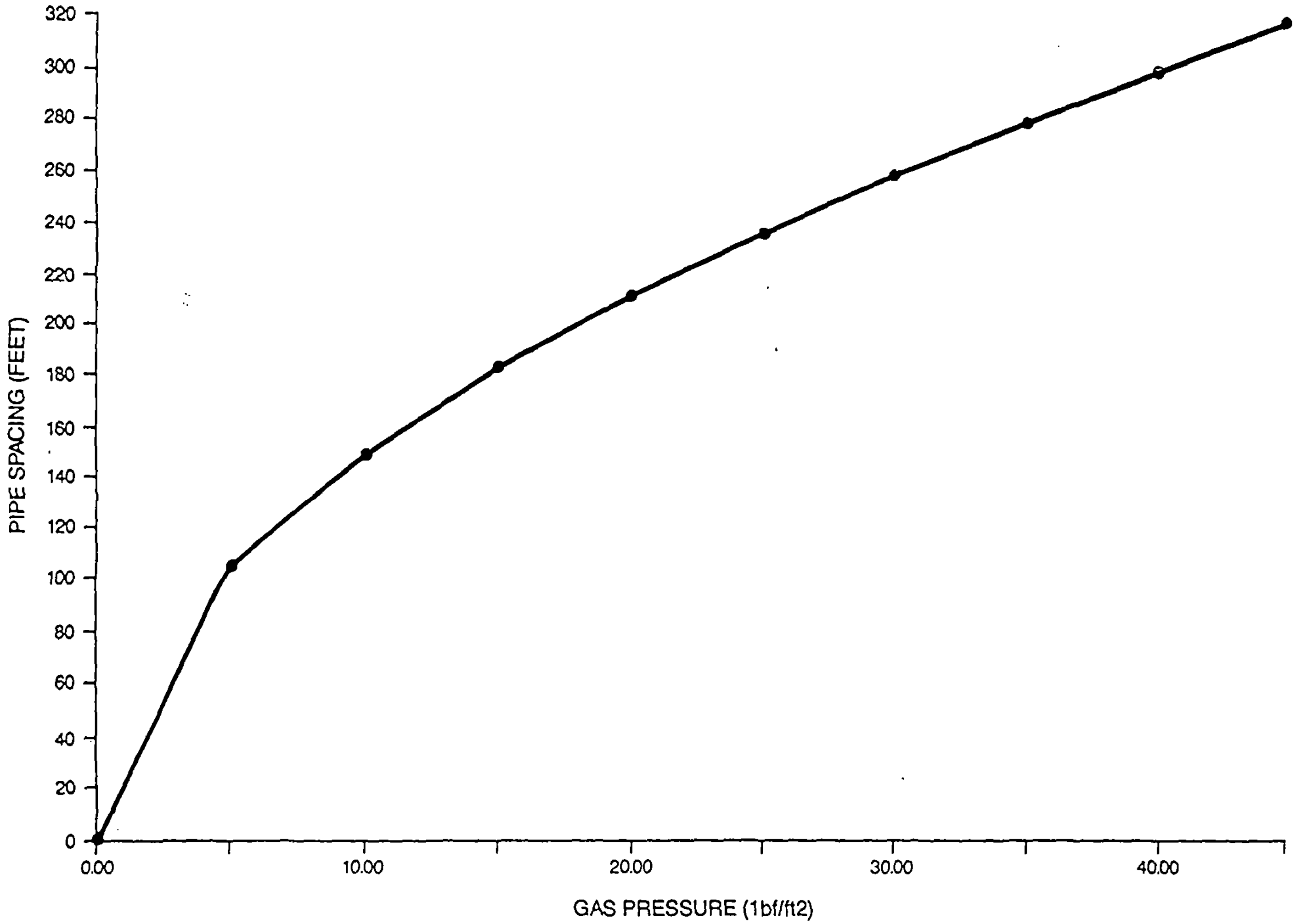
## 4G.4 APPLICATION

A passive system operates without artificially induced pressure gradients, such as a motor blower unit to create a negative pressure (vacuum) in extraction wells. Historically, passive venting systems have been designed primarily on judgment as to vent spacing and size. There is no well defined and accepted method in the literature that allows vent pipes to be spaced based on site specific conditions. The equations presented above were developed to calculate the required spacing of gas vent pipes given site specific conditions and a chosen maximum landfill gas pressure. Typical landfill parameters cited in several literature sources were substituted into the equations. These include the following:

| Parameter | Value | Reference |
|---|---|---|
| Refuse permeability | $7.44 \times 10^{-3}$ ft/hr | (Intrinsic perm. = 1.034 darcys) Fungaroli and Steiner, 1979 |
| Depth ratio ($m_1/m_2$) | 1.0 | assumed for shallow landfills |
| Specific weight | $7.89 \times 10^{-2}$ lbf/ft$^3$ | Schumacher, 1983 |
| Gas pressure ($P_2$) | 15.67 psf | Findikakis and Leckie, 1979 |
| Gas production rate (R) | 0.04 ft$^3$/yr-lb | Schumacher, 1983 |
| Refuse density | 37 lb/ft$^3$ | Tchobanoglous, et al., 1977 |

The graph shown in Figure 4G.1 shows the required pipe spacing versus maximum landfill gas pressure. The curve was derived by inserting the parameter values listed above in Equation (4G-5). The calculation worksheet is included as Table 4G.1. Following is an example of how this equation could be used for a shallow landfill.

If typical landfill gas pressures (16 psf) are not to be exceeded, a pipe spacing of approximately 330 feet is required. The maximum flow distance that methane must travel to reach either a collection pipe or the edge of the landfill, where it can be collected in a perimeter trench, is less than 165 feet. Vertical risers, connected to the vent piping via tee couplings, could be used to vent the gas through the final cover. The risers would incorporate a flare to burn the gases and thereby eliminate potential odor problems.




WDOE Solid Waste

Landfill Design Manual

**Figure 4G.1**
**Gas Migration Control Pipe Spacing Versus Gas Pressure**

TABLE G.1 GAS MIGRATION CONTROL - PASSIVE CONTROL SYSTEM TRENCH SPACING (BASED ON DARCY'S EQUATION)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| K | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 |
| m1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| m2 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| P2 | 2.09 | 5.57 | 6.38 | 11.50 | 15.67 | 21.73 | 50.00 | 100.00 | 150.00 | 211.70 |
| l | 15.3 | 24.9 | 26.7 | 35.8 | 41.8 | 49.2 | 74.6 | 105.6 | 129.3 | 153.6 |
| L | 31 | 50 | 53 | 72 | 84 | 98 | 149 | 211 | 259 | 307 |
| K | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 |
| m1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| m2 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| P2 | 2.09 | 5.57 | 6.38 | 11.50 | 15.67 | 21.73 | 50.00 | 100.00 | 150.00 | 211.70 |
| l | 34.1 | 55.7 | 59.6 | 80.1 | 93.4 | 110.0 | 166.9 | 236.1 | 289.1 | 343.5 |
| L | 68 | 111 | 119 | 160 | 187 | 220 | 334 | 472 | 578 | 687 |
| K | 7.44E-04 | 7.44E-04 | 7.44E-04 | 7.44E-04 | 7.44E-04 | 7.44E-04 | 7.44E-04 | 7.44E-04 | 7.44E-04 | 7.44E-04 |
| m1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| m2 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| P2 | 2.09 | 5.57 | 6.38 | 11.50 | 15.67 | 21.73 | 50.00 | 100.00 | 150.00 | 211.70 |
| l | 4.8 | 7.9 | 8.4 | 11.3 | 13.2 | 15.6 | 23.6 | 33.4 | 40.9 | 48.6 |
| L | 10 | 16 | 17 | 23 | 26 | 31 | 47 | 67 | 82 | 97 |
| K | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 | 7.44E-03 |
| m1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| m2 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| P2 | 0.00 | 5.00 | 10.00 | 15.00 | 20.00 | 25.00 | 30.00 | 35.00 | 40.00 | 45.00 |
| l | 0.0 | 52.8 | 74.6 | 91.4 | 105.6 | 118.0 | 129.3 | 139.7 | 149.3 | 158.4 |
| L | 0 | 106 | 149 | 183 | 211 | 236 | 259 | 279 | 299 | 317 |

K = refuse permeability (ft/hr)
m1 = depth of saturated gas flow (ft)
m2 = depth of refuse (ft)
P2 = landfill gas pressure (psf)
l = flow length (ft)
L = trench spacing (ft)

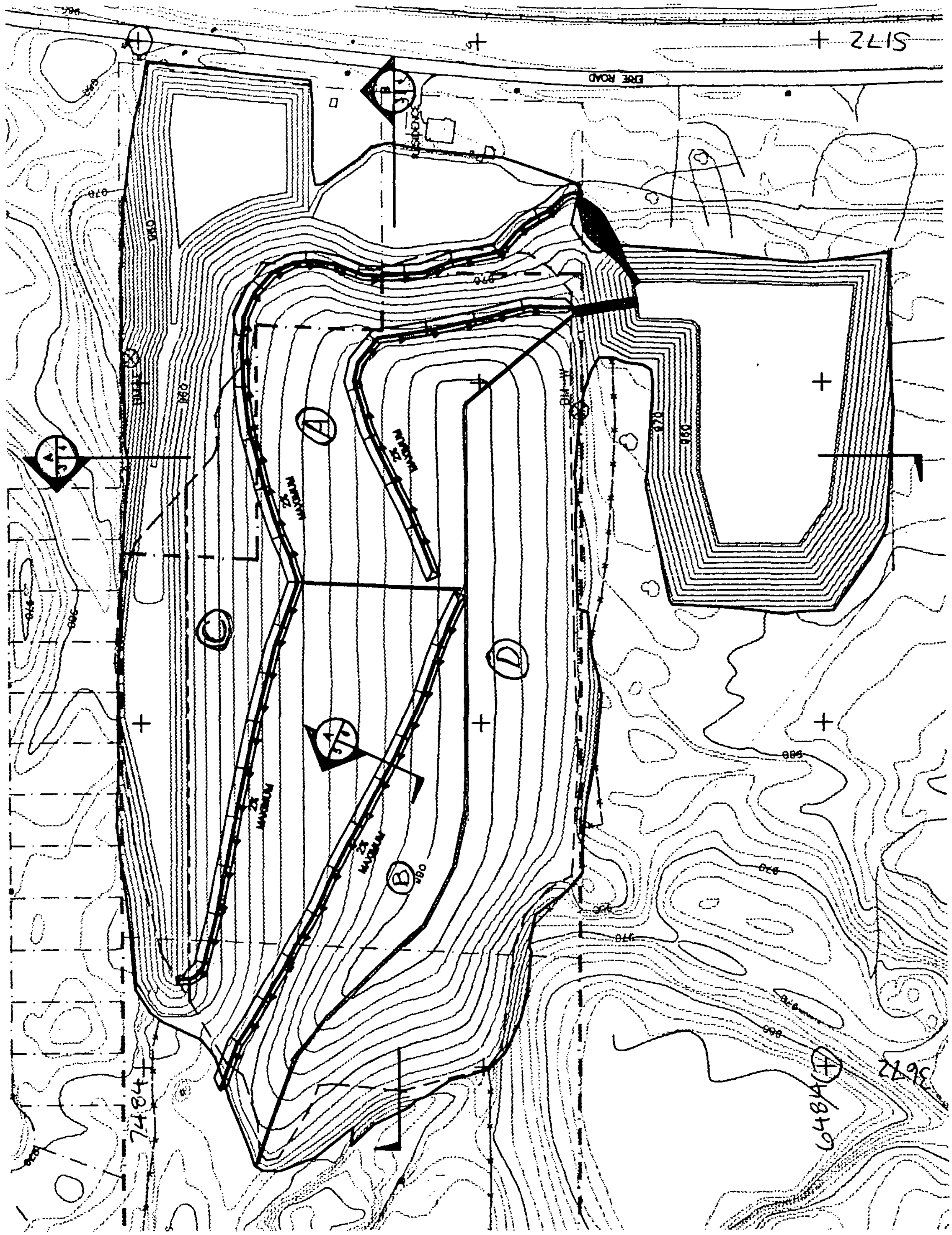
# STORMWATER RUNOFF ANALYSIS

# Runoff Curve Numbers (Ave. Watershed Condition $I_a = 0.2S$

SCS developed a soil classification system consisting of four groups, identified by the letters A, B, C and D. Soil characteristics associated with each group are:

- Group A: deep sand, deep loess, aggregated silts
- Group B: shallow loess; sandy loam
- Group C: clay loams; shallow sandy loams; soils low in organic content; soils
- Group D: soils that swell significantly when wet; heavy plactic clays; certain saline soils

| Land Use Description | Average (%) impervious | Curve Numbers for Hydrologic Soil Group | | | |
|---|---|---|---|---|---|
| | | A | B | C | D |
| Fully developed urban areas (vegetation established) | | | | | |
| Lawns, open spaces, parks, golf courses, cemeteries, etc. | | | | | |
| Good condition; grass cover on 75% or more of the area | | 39 | 61 | 74 | 80 |
| Fair condition; grass cover on 50% to 75% of the area | | 49 | 69 | 79 | 84 |
| Poor condition; grass cover on 50% or less of the area | — | 68 | 79 | 86 | 89 |
| Paved parking lots, roof, driveways, etc. | — | 98 | 98 | 98 | 98 |
| Streets and Roads | | | | | |
| Paved with curbs and storm sewers | | 98 | 98 | 98 | 98 |
| Gravel | — | 76 | 85 | 89 | 91 |
| Dirt | | 72 | 82 | 87 | 89 |
| Paved with open ditches | | 83 | 89 | 92 | 93 |
| Commercial and business areas | 85 | 89 | 92 | 94 | 95 |
| Industrial districts | 72 | 81 | 88 | 91 | 93 |
| Row houses, town houses and residential with lot sizes 1/8 acre or less | 65 | 77 | 85 | 90 | 92 |



ERIE ROAD
RESIDENCE
2% MAXIMUM
A
B
C
D
5172
7484
6484
3672

PROJECT SUMMARY

PROJECT NAME : ALBION-SHERIDAN LANDFILL

RAINFALL : 3045-14

[UNIT HYDROGRAPH]

| | | | | | |
|---|---|---|---|---|---|
| 1 | AREA A | | | | |
| | Type TRIANGULAR UH | Peak flow | 9.392 cfs | Peak time | 19.180 min |
| 2 | AREA B | | | | |
| | Type TRIANGULAR UH | Peak flow | 3.328 cfs | Peak time | 27.133 min |
| 3 | AREA C | | | | |
| | Type TRIANGULAR UH | Peak flow | 18.784 cfs | Peak time | 22.320 min |
| 4 | AREA D | | | | |
| | Type TRIANGULAR UH | Peak flow | 38.857 cfs | Peak time | 5.453 min |

[HYDROGRAPH]

1 AREA A FLOOD
Type COMPUTED FLOOD Peak flow 9.970 cfs Peak time 740.000 min

Unit hydrograph
1 AREA A

2 AREA B FLOOD
Type COMPUTED FLOOD Peak flow 4.038 cfs Peak time 745.000 min

Unit hydrograph
2 AREA B

3 AREA C FLOOD
Type COMPUTED FLOOD Peak flow 21.053 cfs Peak time 745.000 min

Unit hydrograph
3 AREA C

4 AREA D FLOOD
Type COMPUTED FLOOD Peak flow 21.704 cfs Peak time 726.000 min

Unit hydrograph
4 AREA D

[RESERVOIR]

No Reservoirs exist.

[OUTLET STRUCTURE]

No Outlet Structures exist.

UNIT HYDROGRAPH REPORT

RECORD NUMBER : 1
TYPE : TRIANGULAR UH
DESCRIPTION : AREA A

[UNIT HYDROGRAPH INFORMATION]

| | | |
|---|---|---|
| Peak Discharge............................ | = | 9.39 (cfs) |
| Time Interval............................. | = | 5.00 (min) |
| Time to Peak.............................. | = | 19.18 (min) |
| Time of Base.............................. | = | 51.15 (min) |
| Rainfall Excess........................... | = | 1.00 (in) |
| Storm Duration............................ | = | 3.83 (min) |
| Basin Lag Time............................ | = | 17.26 (min) |
| Shape Factor.............................. | = | 484.00 |

[BASIN DESCRIPTION]

| | | |
|---|---|---|
| Watershed Area............................ | = | 3.97 (ac) |
| Curve Number.............................. | = | 74 |

[TIME CONCENTRATION -- TR-55]

SHEET FLOW

| | | |
|---|---|---|
| Manning's Roughness Coef. (n)............ | = | 0.04000 |
| Flow Length (L).......................... | = | 200.00 (ft) |
| 2-yr 24-hr Rainfall (R).................. | = | 2.00 (in) |
| Land Slope (S)........................... | = | 0.05000 |
| Travel Time of Sheet Flow................ | = | 5.20 (min) |

SHALLOW FLOW

| | | |
|---|---|---|
| K_Coef (surface description) (K)......... | = | 0.25000 |
| Watercourse Slope (S).................... | = | 0.02000 |
| Velocity (V)............................. | = | 0.35 (ft/s) |
| Flow Length (L).......................... | = | 500.00 (ft) |
| Travel Time of Shallow Flow.............. | = | 23.57 (min) |

CHANNEL FLOW

| | | |
|---|---|---|
| Hydraulic Radius (R)..................... | = | 0.00 (ft) |
| Channel Slope (S)........................ | = | 0.05000 |
| Manning's Roughness Coef. (n)............ | = | 0.20000 |
| Channel Velocity (V)..................... | = | 0.00 (ft/s) |
| Flow Length (L).......................... | = | 200.00 (ft) |
| Travel Time of Shallow Flow.............. | = | 0.00 (min) |

TIME OF CONCENTRATION

| | | |
|---|---|---|
| Time of Concentration.................... | = | 28.77 (min) |

UNIT HYDROGRAPH REPORT

RECORD NUMBER : 2
TYPE : TRIANGULAR UH
DESCRIPTION : AREA B

[UNIT HYDROGRAPH INFORMATION]

| | | | |
|---|---|---|---|
| Peak Discharge............................ | = | 3.33 | (cfs) |
| Time Interval............................. | = | 5.00 | (min) |
| Time to Peak.............................. | = | 27.13 | (min) |
| Time of Base.............................. | = | 72.36 | (min) |
| Rainfall Excess........................... | = | 1.00 | (in) |
| Storm Duration............................ | = | 5.41 | (min) |
| Basin Lag Time............................ | = | 24.42 | (min) |
| Shape Factor.............................. | = | 484.00 | |

[BASIN DESCRIPTION]

| | | | |
|---|---|---|---|
| Watershed Area............................ | = | 1.99 | (ac) |
| Curve Number.............................. | = | 74 | |

[TIME CONCENTRATION -- TR-55]

SHEET FLOW

| | | |
|---|---|---|
| Manning's Roughness Coef. (n)............. | = | 0.04000 |
| Flow Length (L)........................... | = | 100.00 (ft) |
| 2-yr 24-hr Rainfall (R)................. | = | 2.00 (in) |
| Land Slope (S)............................ | = | 0.05000 |
| Travel Time of Sheet Flow................. | = | 2.98 (min) |

SHALLOW FLOW

| | | |
|---|---|---|
| K_Coef (surface description) (K).......... | = | 0.25000 |
| Watercourse Slope (S)..................... | = | 0.02000 |
| Velocity (V).............................. | = | 0.35 (ft/s) |
| Flow Length (L)........................... | = | 800.00 (ft) |
| Travel Time of Shallow Flow............... | = | 37.71 (min) |

CHANNEL FLOW

| | | |
|---|---|---|
| Hydraulic Radius (R)...................... | = | 0.00 (ft) |
| Channel Slope (S)......................... | = | 0.00000 |
| Manning's Roughness Coef. (n)............. | = | 0.20000 |
| Channel Velocity (V)...................... | = | 0.00 (ft/s) |
| Flow Length (L)........................... | = | 0.00 (ft) |
| Travel Time of Shallow Flow............... | = | 0.00 (min) |

TIME OF CONCENTRATION

| | | |
|---|---|---|
| Time of Concentration..................... | = | 40.70 (min) |

UNIT HYDROGRAPH REPORT

RECORD NUMBER : 3
TYPE : TRIANGULAR UH
DESCRIPTION : AREA C

[UNIT HYDROGRAPH INFORMATION]

| | | |
|---|---|---|
| Peak Discharge............................ | = | 18.78 (cfs) |
| Time Interval............................. | = | 5.00 (min) |
| Time to Peak.............................. | = | 22.32 (min) |
| Time of Base.............................. | = | 59.52 (min) |
| Rainfall Excess........................... | = | 1.00 (in) |
| Storm Duration............................ | = | 4.45 (min) |
| Basin Lag Time............................ | = | 20.09 (min) |
| Shape Factor.............................. | = | 484.00 |

[BASIN DESCRIPTION]

| | | |
|---|---|---|
| Watershed Area............................ | = | 9.24 (ac) |
| Curve Number.............................. | = | 74 |

[TIME CONCENTRATION -- TR-55]

SHEET FLOW

| | | |
|---|---|---|
| Manning's Roughness Coef. (n)............ | = | 0.04000 |
| Flow Length (L).......................... | = | 200.00 (ft) |
| 2-yr 24-hr Rainfall (R)................. | = | 2.00 (in) |
| Land Slope (S)........................... | = | 0.05000 |
| Travel Time of Sheet Flow................ | = | 5.20 (min) |

SHALLOW FLOW

| | | |
|---|---|---|
| K_Coef (surface description) (K)......... | = | 0.25000 |
| Watercourse Slope (S).................... | = | 0.02000 |
| Velocity (V)............................. | = | 0.35 (ft/s) |
| Flow Length (L).......................... | = | 600.00 (ft) |
| Travel Time of Shallow Flow.............. | = | 28.28 (min) |

CHANNEL FLOW

| | | |
|---|---|---|
| Hydraulic Radius (R)..................... | = | 0.00 (ft) |
| Channel Slope (S)........................ | = | 0.00000 |
| Manning's Roughness Coef. (n)............ | = | 0.20000 |
| Channel Velocity (V)..................... | = | 0.00 (ft/s) |
| Flow Length (L).......................... | = | 0.00 (ft) |
| Travel Time of Shallow Flow.............. | = | 0.00 (min) |

TIME OF CONCENTRATION

| | | |
|---|---|---|
| Time of Concentration.................... | = | 33.48 (min) |

UNIT HYDROGRAPH REPORT

RECORD NUMBER : 4
TYPE : TRIANGULAR UH
DESCRIPTION : AREA D

[UNIT HYDROGRAPH INFORMATION]

| | | |
|---|---|---|
| Peak Discharge............................ | = | 38.86 (cfs) |
| Time Interval............................. | = | 1.00 (min) |
| Time to Peak.............................. | = | 5.45 (min) |
| Time of Base.............................. | = | 14.54 (min) |
| Rainfall Excess........................... | = | 1.00 (in) |
| Storm Duration............................ | = | 1.09 (min) |
| Basin Lag Time............................ | = | 4.91 (min) |
| Shape Factor.............................. | = | 484.00 |

[BASIN DESCRIPTION]

| | | |
|---|---|---|
| Watershed Area............................ | = | 4.67 (ac) |
| Curve Number.............................. | = | 74 |

[TIME CONCENTRATION -- TR-55]

SHEET FLOW

| | | |
|---|---|---|
| Manning's Roughness Coef. (n)............. | = | 0.04000 |
| Flow Length (L)........................... | = | 200.00 (ft) |
| 2-yr 24-hr Rainfall (R)................. | = | 2.00 (in) |
| Land Slope (S)............................ | = | 0.05000 |
| Travel Time of Sheet Flow................. | = | 5.20 (min) |

SHALLOW FLOW

| | | |
|---|---|---|
| K_Coef (surface description) (K).......... | = | 0.25000 |
| Watercourse Slope (S)..................... | = | 0.05000 |
| Velocity (V).............................. | = | 0.56 (ft/s) |
| Flow Length (L)........................... | = | 100.00 (ft) |
| Travel Time of Shallow Flow............... | = | 2.98 (min) |

CHANNEL FLOW

| | | |
|---|---|---|
| Hydraulic Radius (R)...................... | = | 0.00 (ft) |
| Channel Slope (S)......................... | = | 0.00000 |
| Manning's Roughness Coef. (n)............. | = | 0.20000 |
| Channel Velocity (V)...................... | = | 0.00 (ft/s) |
| Flow Length (L)........................... | = | 0.00 (ft) |
| Travel Time of Shallow Flow............... | = | 0.00 (min) |

TIME OF CONCENTRATION

| | | |
|---|---|---|
| Time of Concentration..................... | = | 8.18 (min) |

HYDROGRAPH REPORT

RECORD NUMBER : 1
TYPE : COMPUTED FLOOD
DESCRIPTION : AREA A FLOOD

[HYDROGRAPH INFORMATION]

| | | |
|---|---|---|
| Peak Discharge............................ | = | 9.97 (cfs) |
| Volume.................................... | = | 0.99 (acft) |
| Time Interval............................. | = | 5.00 (min) |
| Time to Peak.............................. | = | 740.00 (min) |
| Time of Base.............................. | = | 1489.88 (min) |
| Multiplication factor..................... | = | 1.00 |

[UNIT HYDROGRAPH INFORMATION]

| | | |
|---|---|---|
| Unit hydrograph #......................... | = | 1 |
| Unit hydrograph type...................... | = | TRIANGULAR UH |
| Peak Discharge............................ | = | 9.39 (cfs) |
| Shape Factor.............................. | = | 484.00 |
| Time Interval............................. | = | 5.00 (min) |
| Time to Peak.............................. | = | 19.18 (min) |
| Time of Base.............................. | = | 51.15 (min) |
| Rainfall Excess........................... | = | 1.00 (in) |
| Basin Lag Time............................ | = | 17.26 (min) |

[BASIN DESCRIPTION]

| | | |
|---|---|---|
| Watershed Area............................ | = | 3.97 (ac) |
| Curve Number.............................. | = | 74 |

[TIME CONCENTRATION -- TR-55]

SHEET FLOW

| | | |
|---|---|---|
| Manning's Roughness Coef. (n)............ | = | 0.04000 |
| Flow Length (L)......................... | = | 200.00 (ft) |
| 2-yr 24-hr Rainfall (R)................ | = | 2.00 (in) |
| Land Slope (S).......................... | = | 0.05000 |
| Travel Time of Sheet Flow................ | = | 5.20 (min) |

SHALLOW FLOW

| | | |
|---|---|---|
| K_Coef (surface description) (K).......... | = | 0.25000 |
| Watercourse Slope (S).................... | = | 0.02000 |
| Velocity (V)............................ | = | 0.35 (ft/s) |
| Flow Length (L)......................... | = | 500.00 (ft) |
| Travel Time of Shallow Flow.............. | = | 23.57 (min) |

CHANNEL FLOW

| | | |
|---|---|---|
| Hydraulic Radius (R)..................... | = | 0.00 (ft) |
| Channel Slope (S)........................ | = | 0.05000 |
| Manning's Roughness Coef. (n)............ | = | 0.20000 |
| Channel Velocity (V)..................... | = | 0.00 (ft/s) |
| Flow Length (L)......................... | = | 200.00 (ft) |
| Travel Time of Shallow Flow.............. | = | 0.00 (min) |

TIME OF CONCENTRATION

| | | |
|---|---|---|
| Time of Concentration.................... | = | 28.77 (min) |

[RAINFALL DESCRIPTION]

| | | |
|---|---|---|
| Distribution Type........................ | = | SYNTHETIC |
| Total Precipitation...................... | = | 5.78 (in) |
| Return Period............................ | = | 100 (yr) |
| Storm Duration........................... | = | 24.00 (hr) |

HYDROGRAPH REPORT

RECORD NUMBER : 2
TYPE : COMPUTED FLOOD
DESCRIPTION : AREA B FLOOD

[HYDROGRAPH INFORMATION]

| | | |
|---|---|---|
| Peak Discharge............................ | = | 4.04 (cfs) |
| Volume.................................... | = | 0.50 (acft) |
| Time Interval............................. | = | 5.00 (min) |
| Time to Peak.............................. | = | 745.00 (min) |
| Time of Base.............................. | = | 1506.83 (min) |
| Multiplication factor..................... | = | 1.00 |

[UNIT HYDROGRAPH INFORMATION]

| | | |
|---|---|---|
| Unit hydrograph #......................... | = | 2 |
| Unit hydrograph type...................... | = | TRIANGULAR UH |
| Peak Discharge............................ | = | 3.33 (cfs) |
| Shape Factor.............................. | = | 484.00 |
| Time Interval............................. | = | 5.00 (min) |
| Time to Peak.............................. | = | 27.13 (min) |
| Time of Base.............................. | = | 72.36 (min) |
| Rainfall Excess........................... | = | 1.00 (in) |
| Basin Lag Time............................ | = | 24.42 (min) |

[BASIN DESCRIPTION]

| | | |
|---|---|---|
| Watershed Area............................ | = | 1.99 (ac) |
| Curve Number.............................. | = | 74 |

[TIME CONCENTRATION -- TR-55]

SHEET FLOW

| | | |
|---|---|---|
| Manning's Roughness Coef. (n)............ | = | 0.04000 |
| Flow Length (L).......................... | = | 100.00 (ft) |
| 2-yr 24-hr Rainfall (R)................ | = | 2.00 (in) |
| Land Slope (S)........................... | = | 0.05000 |
| Travel Time of Sheet Flow................ | = | 2.98 (min) |

SHALLOW FLOW

| | | |
|---|---|---|
| K_Coef (surface description) (K)......... | = | 0.25000 |
| Watercourse Slope (S).................... | = | 0.02000 |
| Velocity (V)............................. | = | 0.35 (ft/s) |
| Flow Length (L).......................... | = | 800.00 (ft) |
| Travel Time of Shallow Flow.............. | = | 37.71 (min) |

CHANNEL FLOW

| | | |
|---|---|---|
| Hydraulic Radius (R)..................... | = | 0.00 (ft) |
| Channel Slope (S)........................ | = | 0.00000 |
| Manning's Roughness Coef. (n)............ | = | 0.20000 |
| Channel Velocity (V)..................... | = | 0.00 (ft/s) |
| Flow Length (L).......................... | = | 0.00 (ft) |
| Travel Time of Shallow Flow.............. | = | 0.00 (min) |

TIME OF CONCENTRATION

| | | |
|---|---|---|
| Time of Concentration.................... | = | 40.70 (min) |

[RAINFALL DESCRIPTION]

| | | |
|---|---|---|
| Distribution Type........................ | = | SYNTHETIC |
| Total Precipitation...................... | = | 5.78 (in) |
| Return Period............................ | = | 100 (yr) |
| Storm Duration........................... | = | 24.00 (hr) |

HYDROGRAPH REPORT

RECORD NUMBER : 3
TYPE : COMPUTED FLOOD
DESCRIPTION : AREA C FLOOD

[HYDROGRAPH INFORMATION]

| | | |
|---|---|---|
| Peak Discharge............................ | = | 21.05 (cfs) |
| Volume.................................... | = | 2.30 (acft) |
| Time Interval............................. | = | 5.00 (min) |
| Time to Peak.............................. | = | 745.00 (min) |
| Time of Base.............................. | = | 1497.79 (min) |
| Multiplication factor..................... | = | 1.00 |

[UNIT HYDROGRAPH INFORMATION]

| | | |
|---|---|---|
| Unit hydrograph #......................... | = | 3 |
| Unit hydrograph type...................... | = | TRIANGULAR UH |
| Peak Discharge............................ | = | 18.78 (cfs) |
| Shape Factor.............................. | = | 484.00 |
| Time Interval............................. | = | 5.00 (min) |
| Time to Peak.............................. | = | 22.32 (min) |
| Time of Base.............................. | = | 59.52 (min) |
| Rainfall Excess........................... | = | 1.00 (in) |
| Basin Lag Time............................ | = | 20.09 (min) |

[BASIN DESCRIPTION]

| | | |
|---|---|---|
| Watershed Area............................ | = | 9.24 (ac) |
| Curve Number.............................. | = | 74 |

[TIME CONCENTRATION -- TR-55]

SHEET FLOW

| | | |
|---|---|---|
| Manning's Roughness Coef. (n)............ | = | 0.04000 |
| Flow Length (L).......................... | = | 200.00 (ft) |
| 2-yr 24-hr Rainfall (R)................ | = | 2.00 (in) |
| Land Slope (S)........................... | = | 0.05000 |
| Travel Time of Sheet Flow................ | = | 5.20 (min) |

SHALLOW FLOW

| | | |
|---|---|---|
| K_Coef (surface description) (K).......... | = | 0.25000 |
| Watercourse Slope (S)..................... | = | 0.02000 |
| Velocity (V).............................. | = | 0.35 (ft/s) |
| Flow Length (L)........................... | = | 600.00 (ft) |
| Travel Time of Shallow Flow............... | = | 28.28 (min) |

CHANNEL FLOW

| | | |
|---|---|---|
| Hydraulic Radius (R)...................... | = | 0.00 (ft) |
| Channel Slope (S)......................... | = | 0.00000 |
| Manning's Roughness Coef. (n)............ | = | 0.20000 |
| Channel Velocity (V)...................... | = | 0.00 (ft/s) |
| Flow Length (L)........................... | = | 0.00 (ft) |
| Travel Time of Shallow Flow............... | = | 0.00 (min) |

TIME OF CONCENTRATION

| | | |
|---|---|---|
| Time of Concentration..................... | = | 33.48 (min) |

[RAINFALL DESCRIPTION]

| | | |
|---|---|---|
| Distribution Type......................... | = | SYNTHETIC |
| Total Precipitation....................... | = | 5.78 (in) |
| Return Period............................. | = | 100 (yr) |
| Storm Duration............................ | = | 24.00 (hr) |

\

HYDROGRAPH REPORT

RECORD NUMBER : 4
TYPE : COMPUTED FLOOD
DESCRIPTION : AREA D FLOOD

[HYDROGRAPH INFORMATION]

| | | |
|---|---|---|
| Peak Discharge............................ | = | 21.70 (cfs) |
| Volume.................................... | = | 1.16 (acft) |
| Time Interval............................. | = | 1.00 (min) |
| Time to Peak.............................. | = | 726.00 (min) |
| Time of Base.............................. | = | 1453.89 (min) |
| Multiplication factor..................... | = | 1.00 |

[UNIT HYDROGRAPH INFORMATION]

| | | |
|---|---|---|
| Unit hydrograph #......................... | = | 4 |
| Unit hydrograph type...................... | = | TRIANGULAR UH |
| Peak Discharge............................ | = | 38.86 (cfs) |
| Shape Factor.............................. | = | 484.00 |
| Time Interval............................. | = | 1.00 (min) |
| Time to Peak.............................. | = | 5.45 (min) |
| Time of Base.............................. | = | 14.54 (min) |
| Rainfall Excess........................... | = | 1.00 (in) |
| Basin Lag Time............................ | = | 4.91 (min) |

[BASIN DESCRIPTION]

| | | |
|---|---|---|
| Watershed Area............................ | = | 4.67 (ac) |
| Curve Number.............................. | = | 74 |

[TIME CONCENTRATION -- TR-55]

SHEET FLOW

| | | | |
|---|---|---|---|
| Manning's Roughness Coef. (n)............. | = | 0.04000 | |
| Flow Length (L)........................... | = | 200.00 | (ft) |
| 2-yr 24-hr Rainfall (R)................. | = | 2.00 | (in) |
| Land Slope (S)............................ | = | 0.05000 | |
| Travel Time of Sheet Flow................. | = | 5.20 | (min) |

SHALLOW FLOW

| | | | |
|---|---|---|---|
| K_Coef (surface description) (K).......... | = | 0.25000 | |
| Watercourse Slope (S)..................... | = | 0.05000 | |
| Velocity (V).............................. | = | 0.56 | (ft/s) |
| Flow Length (L)........................... | = | 100.00 | (ft) |
| Travel Time of Shallow Flow............... | = | 2.98 | (min) |

CHANNEL FLOW

| | | | |
|---|---|---|---|
| Hydraulic Radius (R)...................... | = | 0.00 | (ft) |
| Channel Slope (S)......................... | = | 0.00000 | |
| Manning's Roughness Coef. (n)............. | = | 0.20000 | |
| Channel Velocity (V)...................... | = | 0.00 | (ft/s) |
| Flow Length (L)........................... | = | 0.00 | (ft) |
| Travel Time of Shallow Flow............... | = | 0.00 | (min) |

TIME OF CONCENTRATION

| | | | |
|---|---|---|---|
| Time of Concentration..................... | = | 8.18 | (min) |

[RAINFALL DESCRIPTION]

| | | | |
|---|---|---|---|
| Distribution Type......................... | = | SYNTHETIC | |
| Total Precipitation....................... | = | 5.78 | (in) |
| Return Period............................. | = | 100 | (yr) |
| Storm Duration............................ | = | 24.00 | (hr) |

B

**APPENDIX B**
**FINAL REPORT**

# PERFORMANCE MONITORING PLAN ALBION SHERIDAN TOWNSHIP LANDFILL CALHOUN COUNTY, MI

*Prepared for*
Cooper Industries
Houston Texas

and

Corning, Inc.
Corning, New York

August, 1997


**Woodward-Clyde**

38777 West Six Mile Road
Suite 200
Livonia, Michigan 48151
6E13045

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This Performance Monitoring Plan (PMP) was prepared by Woodward-Clyde Consultants (WCC) for Corning, Inc. and Cooper Industries (The Group) to assess the performance of the drum removal and treatment, construction of landfill cap and landfill gas collection system and groundwater monitoring program. This plan has been prepared in accordance with the guidelines set forth in the Unilateral Administrative Order (UAO) prepared for this site (U.S. EPA, October 1995). The site background information presented in Sections 1 and 2 was derived from the Remedial Investigation Report (WW Engineering and Science, April, 1994), the ROD and SOW.

## 1.1 SITE LOCATION AND DESCRIPTION

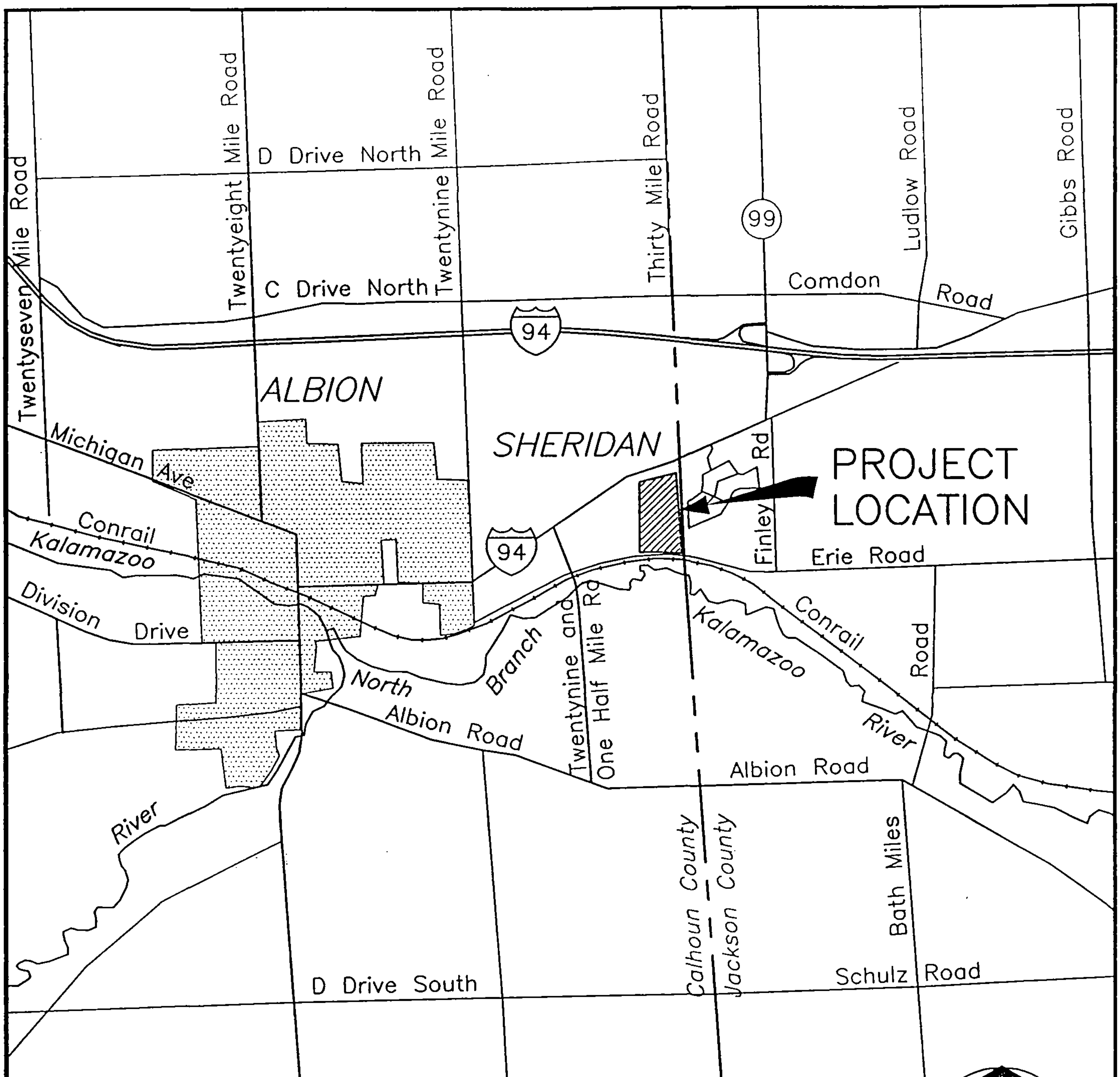
The ASTL is an inactive landfill located at 29975 East Erie Road approximately one mile east of Albion, Michigan on the eastern edge of Calhoun County (Figure 1). The site occupies approximately 18 acres. The site is surrounded by residential, agricultural, commercial and industrial properties. One residence is located immediately adjacent to the landfill to the south and five additional residences are located approximately 1,000 to 1,500 feet (ft) southwest of the landfill along East Erie Road. An active railroad track borders East Erie Road to the south of the landfill, and beyond the railroad tracks lies the North Branch of the Kalamazoo River. South of the river is agricultural land. The site does not fall within the flood plain of the river. There are wetlands south of the site adjacent to the river, but are not expected to be impacted by site activities.

The Amberton Village housing development is located adjacent to the site on the east side, with the closest residences approximately 500 ft from the landfill. Several residences and commercial businesses are located along Michigan Avenue approximately 500 ft north of the site. Immediately west of the site is undeveloped land formerly used for agriculture. The Orchard Knoll subdivision is located approximately 1,500 ft northwest of the landfill. Approximately 2,000 ft northwest of the site is a landfill associated with Brooks Foundry. Approximately one mile west is the City of Albion, with a population of 10,066 according to the 1990 census. This figure does not include approximately 1,700 students enrolled at Albion College located in the City of Albion.

## 1.2 GENERAL LICENSE INFORMATION AND REGULATORY STATUS

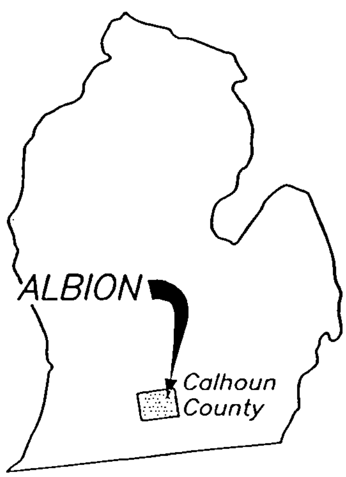
From 1966 to 1981, the landfill was privately owned and operated by Mr. Gordon Stevick. The landfill accepted municipal refuse and industrial wastes from households and industries in the City of Albion and nearby townships. In the early 1970s, the Michigan Department of Natural Resources (MDNR) approved the landfill to accept metal plating sludges. The landfill ceased operation in 1981.

In 1986, a United States Environmental Protection Agency (U.S. EPA) Field Investigation Team contractor performed a Site Screening Inspection for purposes of scoring the site per the Hazard Ranking System (HRS). EPA listed the site on the National Priorities List (NPL) in 1989. In 1991, the site was selected as a demonstration site for the presumptive remedy for CERCLA municipal landfill sites. The U.S. EPA completed a Remedial Investigation (RI - WWES, 1994) report in April 1994. A Record of Decision (ROD), defining the required remedial action for the site, was signed by the Regional Administrator of U.S. EPA Region V on March 28, 1995.




## VICINITY MAP

NOT TO SCALE




N

ALBION–SHERIDAN TOWNSHIP LANDFILL
ALBION, MICHIGAN

**Woodward-Clyde Consultants**
ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS

SITE LOCATION MAP

| | | | |
|---|---|---|---|
| DRN BY: KAH | DATE: MAY 1997 | PROJECT NO. | FIG. NO. |
| CHK'D BY: DS | DATE: MAY 1997 | 6E13045 | 1 |

Respondents declined to enter into a consent decree to conduct the RD/RA for the site in accordance with the ROD and SOW, so the U.S. EPA issued an UAO on October 11, 1995.

## 1.3 SITE HISTORY

The Albion-Sheridan Township Landfill Site had been used as a sand and gravel borrow pit and also used for open, unpermitted dumping for an unspecified period of time prior to 1966. From 1966 to 1981, the landfill was privately owned and operated by Mr. Gordon Stevick. The landfill accepted municipal refuse and industrial wastes from households and industries in the City of Albion and nearby townships. In the early 1970s, the Michigan Department of Natural Resources (MDNR) approved the landfill to accept an estimated 6,000 cubic yards of metal plating sludges. Other materials, such as paint wastes and thinners, oil and grease, and dust, sand, and dirt containing fly ash and casting sand were also disposed of at the site. The sludge remain buried at the site. The landfill ceased operation in 1981.

The drum removal and treatment monitoring is detailed in Appendix C of the Remedial Action Plan and in the Contract Specification 02212 (Appendix E). The Drum Management Plan is prepared in accordance with Section III of the SOW.

## 2.1 PERFORMANCE MONITORING REQUIREMENTS

Air monitoring required by the final health and safety plan and waste characterization testing will occur during the drum removal phase. Material surrounding the buried drums will be left in place with the excavated overburden materials placed on top following excavation/drum removal activities.

Following final disposition of all drummed waste, the laboratory data will be reviewed by The Groups QA Officer and a discussion will be included in the documentation report.

The Construction Quality Assurance Plan (CQAP) included in Appendix C details monitoring and sampling requirements prior to and during construction of the landfill cap that will ensure all performance standards are met. Air emission monitoring requirements during landfill cap construction will be detailed in the HASP. Routine background and downwind fenceline air monitoring for VOCs with a 11.7 eV HNu will be required during landfill cap construction when waste is exposed.

Erosion is limited to 2 ton /acres/ year and areas over 200 $ft^2$ of dead vegetation will require repair. Stormwater ponds/ditches and berm drainage features will be monitored to maintain their function at all times. Additional long-term landfill cap monitoring requirements are discussed in the Draft O&M Plan (Appendix D).

The landfill gas monitoring program is detailed in the Operations and Maintenance Plan (O&M Plan) in Appendix D. The data will be compared to the SOW requirements after review by The Groups QA Officer. The data will be compared to modeled (WCC, 1996) screening levels of the carcinogenic compounds and the individual compound risks will be determined for comparison to the $1x10^{-6}$ total cancer risk limit at the fenceline. If concentrations are those that yield a total cancer risk of $1x10^{-6}$ or less at the fenceline as predicted by the model, specific VOC gas monitoring activities will be discontinued. If the results are above the total cancer risk an additional sampling program will be implemented after consultation with U.S. EPA and MDEQ.

The purpose of the long-term groundwater monitoring is to assess the effectiveness of the remedial action/cap integrity by detecting changes is the chemical concentration of the groundwater at and adjacent to the site. The O&M groundwater monitoring program is detailed in the O&M Plan.

The Group will submit a Contingent Remedy Groundwater Monitoring Report following the five-year Review Groundwater Monitoring event. This report will include results of a statistical test on each monitoring well in which the arsenic concentration exceeded 0.05 mg/L during any sampling event. For each such well, a time plot of arsenic concentration over the five year period will be completed. For those wells at which a downward trend is present, a regression, time series or other model approved by the U.S. EPA will be utilized to predict the date at which arsenic concentrations are predicted to meet 0.05 mg/L arsenic, assuming that the observed trend continues. If the data do not exhibit serial correlation, a regression model will be utilized to estimate a linear or nonlinear trend for the subset of data which represent a downward trend. If the data do exhibit serial correlation, a time series model will be used in lieu of a regression model on the same subset of data.

If so directed by U. S. EPA, in consultation with the MDEQ, the Group will implement the contingent remedy.

Woodward-Clyde Consultants, Remedial Design (RD) Work Plan, Albion-Sheridan Township Landfill, Calhoun County, MI, Vol. 1 and 2, June, 1996.

WW Engineering & Science, Final Remedial Investigation Report of the Albion-Sheridan Township Landfill, Albion, Michigan, April, 1994.

WW Engineering & Science, Final Presumptive Remedy Feasibility Study Report of the Albion-Sheridan Township Landfill, Albion, Michigan, September, 1994.

Woodward-Clyde Consultants, Pre-Design Studies, Albion-Sheridan Township Landfill, Calhoun County, MI, November, 1996.

U.S. EPA Region V (1995) Statement of Work for Remedial Design and Remedial Action at Albion-Sheridan Township Landfill Site, Calhoun County, Michigan.

U.S. EPA Region V (1995) Declaration for the Record of Decision, Albion-Sheridan Township Landfill Site, Albion, Michigan.

U.S. EPA Region V (1995) Unilateral Administrative Order For Remedial Design and Remedial Action, Albion-Sheridan Township Landfill, City of Albion, Corning Glass, Inc., Decker Manufacturing, Inc., and Cooper Industries, Inc., Respondents.

U.S. EPA, Landfill Air Emissions Estimation Model, EPA-60018-90-085a, April, 1991.

U.S. EPA, Air (Superfund National Technical Guidance Study Series, Models for Estimating Air Emission Rates from Superfund Remedial Actions, 1993.

U.S. EPA, Guideline on Air Quality Models, 1987.

C

APPENDIX C
FINAL REPORT

# CONSTRUCTION QUALITY ASSURANCE PLAN ALBION-SHERIDAN TOWNSHIP LANDFILL CALHOUN COUNTY, MI

*Prepared for*
Cooper Industries
Houston, Texas

and

Corning, Inc.
Corning, New York

August, 1997

**Woodward-Clyde**

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## Attachments

## 1.1 PURPOSE OF PLAN

This CQAP describes the responsibility and authority of all organizations and key personnel associated with construction quality evaluations of the Remedial Action (RA). In addition to the CQAP, the following documents are referenced:

- RA Work Plan
- Contract Documents
- Health and Safety Requirements (as outlined in the specifications and included in the Contractor-provided Construction Health and Safety Plan)

The procedures outlined in this CQAP to provide a level of confidence that the work will meet contractual and regulatory requirements, conforms to the design drawings and specifications, and meets or exceeds all design criteria. Observations and documentation of the quality control are the main emphasis of the CQAP. Implementation of the plan will provide evidence that the construction was performed according to the Contract Documents. Documentation associated with CQA activities will assist in identifying problems as they occur during construction, and provide evidence that the problems were addressed before construction is completed.

## 1.2 ORGANIZATION OF REPORTS

This Construction Quality Assurance Plan (CQAP) is part of the Remedial Design (RD) for the Albion-Sheridan Township Landfill (ASTL) Site in Calhoun County, Michigan. Woodward-Clyde Consultants (WCC) has prepared the RD on behalf of Cooper Industries and Corning, Inc. (The Group) according to the Remedial Design Work Plan (RDWP) dated April, 1996, the Record of Decision (ROD) and the subsequent Unilateral Administrative Order (UAO) Statement of Work (SOW) issued for the site.

The RD contains the design drawings and specifications and the associated Remedial Action Implementation Drawings to implement the remedial actions at the Site.

## 1.3 PLAN USERS

Everyone involved in the management of the construction is required to be familiar with this document. All involved parties should review this document with particular attention to those sections applicable to their responsibilities.

## 1.4 SCOPE OF CQAP

The procedures addressed in the CQAP are intended to facilitate construction in accordance with the Contract Documents.

The elements of this plan include: (1) defining the responsibility and authority of organizations and key personnel, (2) presenting the qualifications of the Quality Assurance (QA) Officer and Quality Control (QC) inspection and testing personnel, (3) summarizing the activities, meetings, and required submittals necessary to document landfill component construction activities, (4) introducing the sampling requirements addressed in the specifications, and (5) describing in detail the documentation to be completed, organized and archived at the contract close-out phase of work.

The Landfill cap construction activity consists of the following elements:

Drum Removal and Treatment

- Excavation and handling
- Testing and disposal.
- Soil Testing.

Gas Collection System

- Materials.
- Installation.

Landfill Cover

- General grading and fill.
- Excavation and placement of waste.
- Gas collection/Foundation layer.
- Geotextiles and geosynthetics.
- Flexible Membrane Liner (FML).
- Drainage layer.
- Vegetative soil layer.
- Seeding and mulching.

Stormwater Management System

- Grading and material selection.
- Flow control system inlets and outlets.
- Storm water conveyance system.
- Erosion control system.

Monitoring System

- Groundwater wells.

Security System

- Chainlink fence and gates.

## 2.1 DEFINITION OF PARTIES AND TERMS OF REFERENCE

The Terms of Reference are presented to define the terms used in the CQAP. The identity, qualifications, responsibilities and authority, regarding individuals/parties are discussed in subsequent sections of the Plan.

Construction Quality Assurance: Planned and systematic procedures developed to ensure that materials and services meet the requirements of the specifications. Construction quality assurance complements construction quality control. In general, CQA refers to procedures employed by the Engineer and QA Officer to document that the completed work meets or exceeds design criteria and conforms to the project drawings and specifications.

Construction Quality Control: Construction quality control (CQC) provides a means to measure, regulate, and compare the characteristics of a material and/or service. CQC refers to those actions taken by QC Personnel/Manufacturer(s) to ensure that materials and workmanship meet the requirements of the project.

Contractor: The individual or firm, referred to as the "Contractor," responsible for constructing the landfill component systems in conformance with the project documents. The Contractor will meet the requirements of the General and Supplemental Conditions of the Contract.

Contract Documents: All documents which are incorporated into the contractor's contract will include, the ROD, the Unilateral Administrative Order and SOW, the RA Work Plan, the Project Design Report, the Project Specifications, the Design Drawings, the Project Schedule, the modifications approved at the pre-construction and/or other meetings.

Engineer : The firm responsible for the design and resident engineering responsibilities on behalf of the owner. The Resident Engineer is an individual, designated by the owner as their representative responsible for remedial design and for on-site management of the construction of the RA.

The Design Engineer is the person responsible for the design and shall evaluate all design changes or non-conforming construction.

Material Testing Laboratories: Laboratories utilized to perform physical testing of material samples. The synthetic materials testing laboratories shall be accredited by the Geosynthetic Accreditation Institute - Laboratory Accreditation Program or equivalent for membrane testing. Testing equipment used in the laboratories shall be calibrated at reasonable intervals by devices of accuracy traceable to either the National Bureau of Standards or accepted values of natural physical constants. Laboratories will have personnel qualified and experienced in performing tests required and be able to furnish test results within 3 days of reception of samples.

Owner: Cooper Industries and Corning, Inc. (the Group) are responsible for implementing the ASTL Remedial Action.

Project Coordinator: The individual (or firm) designated by the Group who is responsible for the work required to complete the components of the U.S. EPA RA.

Quality Assurance Officer: The individual (or firm) designated by the Group to be responsible for observing, testing and documenting activities related to the CQA during the construction of the landfill cap.

Quality Control Personnel: The individual (or firm) designated by the Group to be responsible for performing and documenting Quality Control activities during construction of the landfill cap. The Firm providing the QC Personnel will provide to the Group, and the Engineer, the corporate history, inspection capabilities, and resumes of personnel to be assigned to the project for approval.

Surveyor: A registered Surveyor that is not employed by the Contractor. The Surveyor will perform Measurement and Payment surveys as required by the Engineer, and perform QA auditing and verification of the construction survey work performed by the Contractor's surveyor. The Surveyor shall provide certification that the work completed as part of the landfill cover was constructed to the lines and grades indicated on the record/as-built drawings. The Contractor shall be responsible for employing a registered surveyor to develop survey control plan drawings, set survey control, develop cross-sections and record drawings.

## 2.2 PROJECT TEAM ORGANIZATION, RESPONSIBILITIES AND QUALIFICATIONS

A project construction team will be assembled that includes representatives of the Group, U.S. EPA, Michigan Department of Environment Quality (MDEQ), Project Coordinator, Engineer, (and the Resident Engineer and Design Engineer), QC Personnel, QA Officer, Health and Safety Officer, Surveyor, and the Contractor(s). The project team members will be appointed based on their professional qualifications applicable to their responsibilities, training and experience working with similar RA. Reference to the RA Work Plan will provide additional information concerning the qualifications and responsibilities of the individuals forming the project team. The organizational chart for the project team is presented in Figure 2-1.

### 2.2.1 The Group

The Group is responsible for all phases of the RA design, including the project management and construction of the landfill cover for which this CQAP applies. The Group has the responsibility of ensuring that the facility is constructed, within a reasonable degree of certainty, to meet the design criteria as evidenced by complete documentation of CQA activities. The Group has the authority to select, and/or dismiss, parties charged with CQA and construction activities. The Group also has the authority to accept or reject CQA drawings, recommendations of the QA Officer, and the materials and workmanship of the Contractor(s) when such is not in conformance with the requirements of the terms and conditions of the Contract Documents. The Group will designate a Design Engineer who will be responsible for the design of the RA and a Project Coordinator who will be responsible for coordinating the RA activities. The Group will appoint a Resident Engineer responsible for the overall management for all phases of the construction.

### 2.2.2 Project Coordinator

The Project Coordinator will have the responsibility for implementing the remedial action design for the RA and will be responsible for coordinating all phases of the construction and communication with the construction team. As a part of these responsibilities, the Project Coordinator has the authority to accept or reject drawings and specifications for the RA, implementation drawings, reports, and the materials and workmanship of the RA Contractor(s).

### 2.2.3 U.S. EPA Project Manager

U.S. EPA is responsible for the Agency oversight and management of the ASTL RD/RA Program and will designate an individual as the U.S. EPA Remedial Action Project Manager. The U.S. EPA project manager will be responsible for the overview of this project and will coordinate the agency review and approval of the RA.

### 2.2.4 Engineer

The Engineer will have a Resident Engineer that is the Group's on-site representative. The Resident Engineer will be responsible for the on-site management and coordination of the RA construction. The Resident Engineer has the overall responsibility for the construction management at the site and all communications with the Contractor, QC Personnel, Surveyor, and the Project Coordinator.

The Resident Engineer will work closely with the Contractor, QC Personnel, QA Officer, and Surveyor to provide the overall on-site coordination for construction and CQA activities. The Resident Engineer will review and approve (as appropriate) the technical drawings, procedures and policies necessary to complete the project in conformance with the drawings and specifications. The Resident Engineer will monitor activities to ensure that the work performed is in accordance with schedules and will also be responsible for the overall quality of services. The Resident Engineer will prepare and submit all project reports and deliverables to the Project Coordinator.

### 2.2.5 Contractor

The Contractor is responsible for constructing the landfill cover and associated systems in conformance with the project documents. Contractor is responsible for the quality of suppliers, manufacturers, products, services, site conditions and workmanship to produce work of specified quality.

### 2.2.6 QC Personnel

QC will be performed by an individual (or firm) independent of the Contractor. The individual firm must be approved by the Group. The firm providing QC Personnel will provide to the Group, and the Resident Engineer, the following information for the proposed firm: corporate history, proof of insurance, inspection capabilities, and specific related experience and resumes of personnel to be assigned to the project. The Contractor is responsible for scheduling QC activities with the QC personnel during construction.

To facilitate QA/QC activities during construction, the Contractor will furnish incidental labor as required to: (a) provide access to work to be tested, (b) obtain and handle samples at the site or at the source of the product to be tested where and when designated by the Resident Engineer or QA Officer, (c) facilitate inspections, tests and retests. The Contractor will maintain accessibility of the work to the QC personnel and the QA Officer.

The QC personnel will assist the QA Officer in preparing CQA reports. The CQC report will, at a minimum, include: (a) QC personnel field notes; including memorandum of meetings and/or discussions, and (b) QC personnel observation and testing data sheets. Observation and testing data sheets will, typically, include the following information:

- Identify sheet number for cross referencing and document control.
- Date, project name, location, and other identification.
- Weather conditions.
- A reduced-scale Site Plan showing applicable work areas.
- Descriptions and specific locations of work being tested and/or observed.
- Test and sampling locations were taken.
- Summary of test results.
- Calibration or recalibration of test equipment.
- QC documentation for Materials received.
- Identification of the panels/seams completed and approved, and measures taken to protect unfinished areas.
- Identification of seams or panel areas requiring repairs.
- Identification of repairs completed.
- Decisions regarding acceptance of work and/or corrective actions taken in instances of substandard quality.
- QA Officer/Resident Engineer signature.

Items above should be organized on log sheets so that none are overlooked. Sample sheets are included in Attachment A.

The Contractor will employ a surveyor, registered in the State of Michigan, to set survey control benchmarks and earthwork stakes, develop cross-sections, and prepare record/as-built drawings.

The firm providing QC Personnel will provide for the services of independent material testing laboratories to support CQC requirements.

Specific construction QC testing, documentation, and submittal requirements are presented in Specifications 01400 and 01300 of the Contract Documents (Appendix E).

### 2.2.7 QA Officer

The QA Officer is responsible for completing audits of and providing documentation that materials and construction are in accordance with the project drawings and specifications. The QA Officer shall be an individual or established professional engineering firm incorporated or registered in the State of Michigan. The QA Officer is responsible for providing qualified personnel to observe and document landfill component construction and to certify that the construction, as observed, was performed in accordance with the specifications.

The QA Officer is responsible for reviewing Contractor's CQC data and performing CQA sampling and testing to confirm Contractors' CQC and manufacturer's quality control. The QA Officer will provide personnel with the appropriate academic training/experience in order to fulfill their specific responsibilities.

The QA Officer, or his/her designee, (e.g., the Resident Engineer) shall observe and document the quality control activities in sufficient detail and continuity to provide a level of confidence that the construction complies with the Contract Documents. The QA Officer may accept or reject construction not in conformance with the specifications. The QA Officer may inform the Resident Engineer to direct the Contractor(s) to test or retest to provide the required degree of certainty that the specified material(s) properties and the design requirements are achieved.

The QA Officer, his/her designee, shall maintain daily reports of construction and QA/QC activities. These daily CQA reports will, at a minimum, include: (a) field notes; including memoranda of meetings and/or discussions, (b) QA observation and testing data sheets, (c) QC observation and testing data sheets, and (d) construction problem and solution data sheets.

If a deficiency is discovered in the earthwork, the QA Officer shall immediately determine the extent and nature of the deficiency. If the deficiency is indicated by an unsatisfactory test result or unacceptable condition, the QA Officer shall evaluate the extent of the deficient area by additional tests, observation, a review of records, or other appropriate methods.

It is the responsibility of the QA Officer or his/her designee to report to the Resident Engineer and Contractor, any problem, deficiency, or deviation from the Contracts Documents. The QA Officer will schedule appropriate retesting through the Resident Engineer, performed at the Contractor's expense, after the deficiency is corrected.

All retests and inspections performed under the direction of the QA Officer must confirm that the deficiency has been corrected before any additional work is performed in the area of the deficiency. The QA Officer will audit records and constructions to confirm that applicable construction requirements are met and that all CQC submittals are provided.

Specific construction QC testing, documentation, and submittal requirements are presented in Specifications 01400 and 01300 of the Contract Documents (Appendix E).

The qualifications of the CQA Officer shall be as follows:

- A minimum of 5 years related experience.
- The candidate shall have a minimum of 3 years field experience with projects involving construction of landfill liners or covers. This experience shall include at a minimum: interpretation of contract and specifications, resolving issues with

Contractor and The Group, general performance of construction personnel and equipment, field surveying techniques, and safe work practices.

- The candidate shall be knowledgeable of laboratory testing procedures (i.e., particle size, permeability, protors, etc.), and field testing (density, moisture content, etc.) of soil liner and cover materials.
- The candidate shall have at least 2 million square feet of geosynthetic inspection experience, including FML's, geosynthetic clay liners, geonets, and geotextiles and be versed in interpretation of geosynthetic laboratory test results for these synthetics.
- The candidate shall be familiar with construction invoices, schedules, issuing of work/change orders, shop drawings and other related items generally included as contractor submittals.

### 2.2.8 Surveyor

The Surveyor will be a professional engineer or land surveyor registered in the State of Michigan. The Surveyor, contracted to the Group and independent of the Contractor's surveyor, may elect to perform Measurement and Payment surveys as required by the Resident Engineer and perform QA auditing and verification of the construction survey work performed by the Contractor's Surveyor. The Surveyor shall provide certification that the work completed as part of the landfill cover was constructed to the lines and grades indicated on the record/as-built drawings. The Surveyor will work under the direction of the Resident Engineer and QA Officer.

To ensure a high degree of quality during construction, clear channels of communication are essential.

## 3.1 PRECONSTRUCTION MEETINGS AND INSPECTIONS

The preconstruction meeting is discussed in Section 01039 of the Construction Specifications.

## 3.2 PROGRESS MEETINGS

Regularly scheduled progress meetings will be held at the project field office of the Contractor. The progress meetings will be held every Fourteen (14) days or less with the first meeting one week after the preconstruction meeting or one week or less after the date of Notice to Proceed. The Resident Engineer may call for additional meetings as necessary.

The Contractor will attend all progress meetings, and review previous meeting minutes prepared by the Resident Engineer, or his designee, and the current agenda items. The Contractor will be prepared to discuss pertinent topics such as deliveries of materials, equipment and progress of the work.

Submittals required at, or before, each progress meeting include (a) construction Schedule, (b) Monthly Status Report, and (c) Progress photos.

A detailed description of the progress meetings are provided in Section 01039 of the Project Specifications.

## 3.3 PROBLEM/DEFICIENCY MEETINGS

A problem/deficiency meeting or telephone conference call shall be conducted when a problem or deficiency is present or likely to occur. The purpose of the meeting is to define and resolve the problem or deficiency. The meeting will be held at the project field office of the Contractor. The QA Officer (or his/her designee) shall document and distribute minutes of problem/deficiency meetings. A detailed description of the problem deficiency meetings are provided in Section 01039 of the specifications.

## 3.4 PRE-FINAL INSPECTION

The Resident Engineer shall notify Project Coordinator, the Group, U.S. EPA, MDEQ, and Contractor for the purposes of conducting a Pre-final Inspection of landfill cover construction. Inspection will be held approximately two weeks after preliminary determination that construction is complete. The inspection shall consist of a walk-through inspection of the entire project.

A Pre-final Inspection Report will be prepared by the Resident Engineer and QA Officer for submission to U.S. EPA and MDEQ within fifteen (15) days after completion of the Pre-Final Inspection. This report will outline the outstanding construction items (incomplete/incorrect), actions to resolve items, completion date(s) for items, and date for Final Inspection.

## 3.5 FINAL INSPECTION

Resident Engineer shall notify Project Coordinator, the Group, U.S. EPA, MDEQ, and Contractor for the purposes of conducting a Final Inspection when outstanding construction items have been completed and within fifteen (15) days of completion of work identified in the Pre-final Inspection Report. The final inspection shall consist of a site walk-through. The Pre-final Inspection Report will be used as a checklist for the final inspection.

The Resident Engineer and QA Officer shall prepare the Pre-final Inspection Report for submittal to U.S. EPA and MDEQ after thirty (30) days of completion of the Final Inspection. A registered professional engineer and the Project Coordinator will certify in this report that all items contained within the UAO and accompanying documents have been completed and that the remedy is functional and meets the design specifications.

## 4.1 CONSTRUCTION QA EVALUATION

Construction quality assurance evaluations shall be performed on all components of the construction. Criteria to be used for determination of acceptability of the construction work shall be as identified in the Contract Documents.

Construction evaluation testing will consist of: 1) Quality Control inspection, field and laboratory tests of the work, and 2) Quality Assurance auditing of quality control activities (to be performed by the QA Officer).

The Group representative will appoint, employ and pay for services of a Quality Assurance Officer (QA Officer) to perform QA inspection and testing as specified in Section 01400 of the Contract Documents. Neither observations by the QA Officer, nor inspections, tests, or approvals by other than the Group's Representative shall relieve the Contractor from his obligation to perform the work in accordance with the requirements of the Contract Documents.

## 4.2 QA OFFICER QUALIFICATIONS AND RESPONSIBILITIES

The QA Officer will comply with all quality assurance requirements of Section 01400 of the Contract Documents and this CQAP. General responsibilities of the QA Officer include the following:

- Perform confirmation inspections, tests, and other services specified in the individual specification sections as requested by the Engineer.
- Employ and pay for the services of an independent testing laboratory (or laboratories) to perform specified services and tests.
- Obtain approval of the Group's representative before employing laboratory (or laboratories).
- Secure and deliver to the laboratory adequate quantities of representative samples of materials, for requested testing.
- Utilize laboratories accredited by the Geosynthetic accreditation Institute's - Laboratory Accreditation Program or equivalent for membrane testing.
- Check to assure testing equipment has been calibrated at reasonable intervals by devices of accuracy traceable to either the National Bureau of Standards or accepted values of natural physical constants.
- Notify laboratory sufficiently in advance of operations to allow for laboratory assignment of personnel and scheduling of tests.
- Pay costs of testing laboratory services except for tests requested or required to be provided by the contractor.
- Estimate the extent and nature of deficiencies identified from observations or testing by performing additional tests, observations, a review of records, or other appropriate methods.

- Notify the Engineer and Contractor of deficiencies and schedule appropriate retesting after the deficiency is corrected.
- Confirm that all installation requirements are met and that all QC submittals are provided by the Contractor.
- Complete a daily report and logs on prescribed forms following procedures of the CQAP.

The qualifications of the QAO shall include:

- Has at least 5 years engineering experience with at least 3 years experience with landfill design and construction.
- Accomplished the responsibilities QAO on at least one other CERCLA site.
- Has experience on at least five CERCLA projects as project manager, project director or QAO.
- Is a registered professional engineer in Michigan.

## 4.3 QC PERSONNEL QUALIFICATIONS AND RESPONSIBILITIES

The QC Personnel will perform all inspections and tests prescribed by the quality control requirements (Section 01400) of the Contract Documents. The Contractor is responsible for compliance with all Quality Control requirements of the Contract Documents. General responsibilities of the QC Personnel include the following:

- Perform or be responsible for all quality control inspections and testing using a qualified individual or firm (accepted by the Group).
- Employ and pay for the services of an independent soil testing laboratory to perform geotechnical tests required by the project specifications.
- Provide geosynthetic testing services necessary to demonstrate the materials of the liner is in accordance with Specification 01400 during the installation of the liner. Testing shall be reviewed by the QA Officer for conformance with the technical requirements presented in the specifications.
- Select a qualified and experienced laboratory to perform tests as specified for FML. The laboratory and shall be able to furnish test results within 3 days of reception of samples. The following laboratories have been pre-qualified for performing the required FML testing:

| | |
|---|---|
| GeoSyntec Consultants | J&L Testing Co., Inc. |
| 621 NW 53rd St., Suite 650 | 938 S. Central Ave. |
| Boca Raton, FL 33487 | Canonsburg, PA 15317 |
| (800) 926-4436 | (412) 746-4441 |
| | |
| Advanced Terra Testing, Inc. | TRI-Environmental, Inc. |
| 833 Parfet St. | 9063 Bee Caves Road |
| Lakewood, CO 80215 | Austin, TX 78733 |
| (303) 232-8308 | (800) 880-8378 |

- Utilize laboratories that are accredited by the Geosynthetic Accreditation Institute's - Laboratory Accreditation Program or equivalent for membrane testing.
- Calibrate testing equipment at reasonable intervals by devices of accuracy traceable to either the National Bureau of Standards or accepted values of natural physical constants.
- Cooperate with the QA Officer; furnish samples of materials, design mix, equipment, tools, storage and assistance as requested.
- Secure and deliver to the laboratory adequate quantities of representative samples of materials which require prequalification testing.

## 4.4 CONTRACTORS QUALIFICATIONS AND RESPONSIBILITIES

The Contractor shall provide for the following:

- Furnish incidental labor and facilities:
    - ♦ To provide access to work to be tested.
    - ♦ To obtain and handle samples at the project site or at the source of the product to be tested where and when designated by the QC Personnel, Engineer or QA Officer.
    - ♦ To facilitate inspections and tests.
    - ♦ For storage and curing of test samples as appropriate.
- Correct deficiencies identified by the QC Personnel, QA Officer or Resident Engineer to the satisfaction of the Resident Engineer.
    - ♦ All retests performed must confirm that the deficiency has been corrected before Contractor may perform any additional work in the area of the deficiency.
    - ♦ Assume costs associated with retesting required due to non-conformance with specified requirements. Payment for retesting will be charged to the

Contractor by deducting inspection or testing charges from the Contract Sum/Price.

- Assume the costs associated with providing the QA Officer test results, statements and certificates indicating the quality of materials and equipment used in the performance of work under this Contract. All costs of this testing and providing statements and certificates of quality assurance shall be a subsidiary obligation of the Contractor, and no extra charge to the Group shall be allowed on account of such testing and certification.
- Notify QC Personnel sufficiently in advance of operations to allow for field and laboratory assignment of personnel and scheduling of tests.
- Obtain approval of the Group before employing any laboratory (or laboratories).
- Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.
- Comply fully with manufacturers' instructions, including each step in sequence.
- Request clarification from Resident Engineer before proceeding with Manufacturers' instructions that conflict with Contract Documents.
- Comply with specified standards as a minimum quality for the work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- Contractor shall require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces, installation, and quality of workmanship, as applicable, and to initiate instructions when necessary.
- Contractor shall submit qualifications of Manufacturer's Representative to Engineer 30 days in advance of required observations. The Manufacturer's Observer is subject to approval of Resident Engineer.
- Contractor and Manufacturer's Representative shall report to the Resident Engineer observations and site decisions or instructions given to installers that are supplemental or contrary to manufacturers' written instructions.
- Contractor shall submit to the QA Officer a report detailing Manufacturer's Representative activities within 30 days of observation to Engineer for review.

The qualifications of the Contractor shall include:

- Has completed at least five landfill capping projects.
- Has completed the installation of at least two million square feet of HDPE geomembrane.
- Is a licensed contractor in Michigan.

## 4.5 INSPECTION AND TESTING REQUIREMENTS

Construction quality control (QC) will be conducted by the QC personnel. No testing or inspection by others shall relieve the Contractor from meeting the requirements of the contract documents. The contractor may employ independent QC personnel to assist the Contractor in meeting quality requirements.

Construction activities subject for inspection and testing include, but are not limited, furnishing, installing and maintaining site roads, cover system, stormwater drainage, slope protection and erosion control, gas collection and venting system, monitoring well installation, abandonment of wells, perimeter fence and landscape grading and seeding.

Specifications for work associated with the construction of the landfill cover and other systems required to complete the remedial action as specified by the ROD and the SOW are included in Appendix E of the Final Design Document.

### 4.5.1 Waste Consolidation

As part of the site grading plan, approximately 50,000 cubic yards of waste materials shall be relocated from the east and north sections of the landfill. Some of the waste is located on adjacent properties. Specific areas of waste excavation and waste placement are shown on the Drawings. The waste excavation and handling work shall occur during the period indicated on the approved final construction schedule and precede the rough site grading and shaping process of the Gas Collection/Foundation Layer placement.

Waste shall be excavated in narrow strips to minimize the area of waste exposed at any one time. The open excavation area shall not exceed 100 feet by (x) 300 feet at any given time. Edges of the excavation shall conform to recommended side slope configurations of 1 (vertical) to 1 (horizontal).

Waste placement shall be done in lifts no greater than four (4) feet thick and compacted with a minimum of three passes of a Caterpillar Model 826 trash compactor or equal approved by the Engineer. Daily cover having a minimum thickness of six (6) inches shall be placed over all consolidated waste at the end of each working day utilizing on-site borrow materials from sources shown on the Drawings.

Grades for the placement area designated in the Drawings range from 4%-25%. In no situation shall the grades vary from this range for the final graded waste surface. The general shape of the graded waste surface shall be completed to that shown in the Drawings and to the satisfaction of the Engineer.

On-site air monitoring shall be done consistent with that outlined in the Contractor's site specific Health and Safety Plan during the period of waste movement. This is to include both the excavation and placement areas when waste materials are exposed.

### 4.5.2 Gas Collection/Foundation Layer

Gas Collection/Foundation Layer soils are on-site granular soils that contain no waste. A minimum of 12 inches of Gas Collection/Foundation Layer fill will be placed over the entire waste mass. Placement of this layer is intended to be in concurrence with the required 6 inch daily cover placed over the consolidated waste body upon reaching design grades. The Gas Collection/Foundation Layer will be utilized to provide a final shape to the landfill surfaces suitable for geomembrane placement as well as providing a buffer between the waste and geomembrane required by the Michigan Department of Environmental Quality (MDEQ) Act 641 Rules.

Shaping the landfill surface (rough grading) involves smoothing and shaping the existing slope to minimize sharp grade changes and eliminating depressions. Abrupt deviations in the finished surface shall not exceed 0.2 feet. No grades steeper than 4H:1V (25%) are allowed. The general grading of the site must be completed to the satisfaction of the QC personnel.

The gas collection/foundation layer will be placed and compacted in accordance with Section 02220 of the Project Specifications. The QC personnel shall visually observe the placement and compaction methods and document lift thicknesses, equipment types and number of passes. The uppermost twelve (12) inches of gas collection/foundation fill shall be tested to evaluate relative compaction and moisture content. Gas Collection/Foundation Layer soils shall be compacted to a minimum of 90% of the Standard Proctor. The test program is shown below.

**GAS COLLECTION/FOUNDATION LAYER TEST PROGRAM**

**(UPPER 12 INCHES OF LAYER)**

| Test Description | ASTM Designation | Minimum Test Frequency |
|---|---|---|
| Field Density and Water Content by Nuclear Method | D2922-81 | One (1) test per 1600 cubic yards |
| Moisture Density Relations Standard Proctor | D698-78 | One (1) test per 8000 cubic yards or one (1) test per acre |
| Mechanical Analysis | D1140 | One (1) test per 1000 cubic yards or two (2) tests per acre |

The uppermost lift of the Gas Collection/Foundation Layer shall be prepared in accordance with Section 02220 of the Project Specifications. The QC personnel will observe the sealing of the surface by smooth drum rolling and check for unstable areas that may impede proper placement of the geomembrane. Any unstable areas will need to be excavated and replaced with compacted Gas Collection/Foundation Layer soils. The final surface of the layer shall be free of angular shaped soil particles, those greater in diameter than the number 4 sieve and any other deleterious material that could damage the geomembrane. Final surface grades and conditions will be inspected by the Engineer and geomembrane installer with any unsatisfactory areas repaired to their requirements.

Once the surface preparation of the Gas Collection/Foundation Layer is completed to the satisfaction of the Engineer, the finished surface will be surveyed by the Contractor to document surface elevations. A grid pattern will be established. The grid should be no larger than 100 feet by 100 feet. Additional grid points should be established at all breaks in grade. The Contractor will provide the survey information to the QC personnel in digital format as record documentation data.

### 4.5.3 Flexible Membrane Liner Construction Quality Assurance

The performance of the landfill cap is dependent upon the integrity of the FML. Construction of the liner must be in accordance with the Project Specifications. The FML is an integral part of the liner system. The FML for this project is a Linear Low Density (LLDPE) Geomembrane Liner.

To confirm that the geosynthetic membrane material and installation are in accordance with the Project Specifications, manufacturing QC and CQC testing and observations shall be employed. See Attachement A for CQA checklists and report forms.

Quality control and CQC testing and inspection are necessary to complete the CQA Plan and include: (1) raw materials, (2) manufactured products and (3) installation.

#### *GEOMEMBRANE MANUFACTURING AND DELIVERY*

<u>Geomembrane Manufacturing</u>

The QC Personnel shall confirm that the geomembrane selected meets the Project Specifications (02778) requirements. The QC Personnel shall examine Manufacturer's product data and affidavits obtained by the Installer and shall perform visual inspections on the delivered materials.

The QC Personnel shall confirm that:

- Property values are certified by the Manufacturer and that they meet or exceed all of the requirements given in the Project Specifications, and
- Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable
- The QC certificates are provided at the required frequency and that each certificate identifies the related rolls

**Rolls.** Prior to shipment, the Installer shall provide the Resident Engineer the QC certificates from the Manufacturer. The QC certificates shall be signed by a responsible party employed by the Manufacturer, such as the Production Manager. The QC certificates shall include:

- Manufacturer's name, location and date or production
- Roll number and identification, and

- Sampling procedures, test methods and results of QC tests. As a minimum, results shall be given for thickness, tensile strength, and tear resistance, in accordance with the test methods outlined in the Project Specifications

Conformance Testing

Upon delivery of the rolls of geomembrane, the QC Personnel shall confirm that one conformance sample per manufactured order is removed and forwarded to a geosynthetics Quality Assurance Laboratory for testing to ensure conformance to both the Project Specifications and the Manufacturer's guaranteed properties.

At a minimum, the following tests shall be performed:

- Density (ASTM D-792)
- Carbon black content (and visual inspection to evaluate carbon black dispersion) (ASTM D-1603)
- Thickness (measured with calipers at random locations on the sample), (ASTM D-1593)
- Tensile characteristics (yield strength, elongation at yield, break strength, elongation at break) (ASTM D-638) and
- Elongation properties (ASTM D-698)

Sampling and testing procedures shall be performed in accordance with the Project Specification (02778). The QC Personnel shall examine all conformance test results and report these to the Resident Engineer.

Shipment, Storage and Handling

Shipping of the geomembrane is the responsibility of the Manufacturer, or other party agreed upon. All handling on site is the responsibility of the Installer.

The QC Personnel shall confirm:

- Handling equipment and personnel used do not pose any risk of damage to the geomembrane

Upon delivery, the Installer and the QC Personnel shall conduct observations of all rolls for defects and damage. This observation shall be conducted without unrolling rolls unless defects or damages are found or suspected. The QC Personnel shall report to the Resident Engineer:

- Rolls which should be rejected and removed from the site because they have severe flaws, and
- Rolls which include minor repairable flaws

**Storage.** The Installer shall be responsible for the storage of the geomembrane. The Contractor shall provide storage space in a location such that site transportation and handling are minimized.

The QC Personnel shall confirm that the geomembrane is protected against dirt, impact, theft, vandalism and traffic.

## GEOMEMBRANE INSTALLATION

Panel Layout Plan

The Installer will submit for review and approval a panel and seam location plan prior to installation to the Resident Engineer.

Earthworks

**Surface Preparation.** The Contractor shall be responsible for preparing the supporting surface according to the Project Specifications.

The QC Personnel shall confirm that:

- A qualified land surveyor has verified all lines and grades
- The supporting surface meets the requirements outlined in the Project Specifications
- The surface to be lined has been rolled and compacted so as to be free of irregularities, protrusions, loose soil, and abrupt changes in grade
- The supporting surface soil does not contain material which may be damaging to the geomembrane, and
- The supporting surface has not been softened by high water content, or has been subject to desiccation.

The QC Personnel shall obtain certification from the Installer that the surface on which the geomembrane will be placed is acceptable. The Certificate of Acceptance shall be provided prior to the geomembrane installation.

After the surface has been accepted by the Installer, it is the Installer's responsibility to indicate to the QC Personnel any change in surface condition that may require repair. If the QC Personnel concurs with the Installer, then the Resident Engineer shall be notified and the QC Personnel shall ensure that the surface is repaired. Care shall be taken to avoid desiccation of the supporting surface. Upon placement of panel(s), the Installer is responsible for maintaining/repairing the surface covered by the geomembrane (unless otherwise agreed).

**Anchor System.** The anchor trench shall be excavated by the Contractor to the lines and widths shown on the design drawings, prior to geomembrane placement. The QC Personnel shall confirm that the anchor trench has been constructed according to the Project Specifications.

If the anchor trench is excavated in a clay layer, no more than the amount of trench required for the geomembrane to be anchored in one day shall be excavated. Slightly rounded corners/edges shall be provided to avoid sharp bends in the geomembrane. No loose soil shall be allowed to underlie the geomembrane.

Backfilling of the anchor trench shall be conducted in accordance with the Project Specifications.

Geomembrane Placement

**Panel Identification.** A panel is the unit area of geomembrane placed and seamed in the field, i.e., a field panel is a roll or a portion of roll placed in the field.

It shall be the responsibility of the QC Personnel to ensure that each panel is given a number consistent with the panel layout plan. The identification number(s) shall be agreed upon by the Resident Engineer, Installer and QC Personnel. The panel numbering system shall be simple and logical and will be used for all CQA records.

The QC Personnel shall establish a table or chart relating manufacturing to panel number(s).

**Panel Placement.** Panel placement shall be in accordance with the Project Specification (02778). The QC Personnel shall observe installation procedures to confirm that they conform to these requirements. The QC Personnel shall confirm that panels are installed in the locations indicated on the panel layout plan. Variations from the plan must be approved by the Resident Engineer.

**Installation Schedule.** Placing only the number of panel(s)that can be seamed and/or tack-welded during the working period is recommended. Care must be taken in the panel placement sequence and ballasting protection that the surface covered by the geomembrane will not be damaged (i.e., water, wind).

The QC Personnel shall evaluate every change in the installation schedule proposed by the Installer and advise the Project Manager on the acceptability of that change.

The QC Personnel shall record the identification number, location, date, time, ambient temperature, and repairs for each panel installed.

**Weather Conditions.** Geomembrane placement shall not proceed at an ambient temperature below 34°F or above 104°F, during any rain, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds.

**Method of Placement.** The QC Personnel shall confirm:

- Equipment used does not damage the geomembrane by handling, excessive heat, leakage of hydrocarbons or other means
- The supporting surface has not deteriorated since previous acceptance, and is still acceptable for geomembrane placement
- Geosynthetics to be covered by the geomembrane are clean and free of debris
- Personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in activities which could damage the geomembrane
- Method used to place the panels do not cause scratches or crimps in the geomembrane and do not damage the supporting surface or underlying geosynthetics
- Method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels)
- Temporary ballasting (e.g., sand bags, tires), has been placed to prevent slippage and uplift by wind and ballast and method of placing does not damage the geomembrane
- Direct contact with the geomembrane is minimized; i.e., the geomembrane is protected in areas where traffic may be expected

**Damage**. The QC Personnel shall observe panels after placement and until completion of installation for damage. The QC Personnel shall advise the Resident Engineer which panels, or portions of panels, should be rejected, repaired or accepted. Damaged panels or portions of panels which have been rejected shall be marked and their removal from the work area recorded by the QC Personnel. Repairs shall be made according to procedures described in Section 6.3.5.

The Installer is responsible for maintaining/repairing the supporting surface covered by the geomembrane. Precautions must be taken by the Installer to avoid damage to the supporting surface, including damage from weather (unless otherwise agreed).

Field Seaming

A field seam numbering system compatible with the panel numbering system shall be agreed upon.

The QC Personnel shall confirm that seams are located as follows: (1) oriented parallel to the line of maximum slope, i.e., oriented along, not across, the slope, (2) in corners and odd-shaped locations, the number of seams are minimized, (3) horizontal seams are greater than five feet from the toe of the slope, or areas of potential stress concentrations, unless otherwise authorized.

**Requirements of Personnel**. All personnel performing seaming operations shall be qualified as outlined in the Project Specification (02778). The QC Personnel shall review the list of seaming personnel and their experience records, provided by the Installer, and confirm qualifications. He shall disqualify inexperienced seamers unless they pass a seaming test overseen by a "Master Seamer" and QC Personnel.

**Seaming Methods**. Approved seaming methods are extrusion welding and fusion wedge welding. The equipment to be used will be approved by make and model number. Sufficient seaming equipment and spare parts will be maintained on-site in order not to delay the project.

**Extrusion Welder**. The extrusion welder will be equipped to provide the temperatures in the apparatus and at the nozzle. Should the apparatus not be equipped for nozzle temperatures, this will be provided by a pyrometer reading. A pyrometer reading will be taken of the extrudate exiting from the nozzle. These readings shall be documented at appropriate intervals.

Extrudate

- The Installer/Manufacturer shall certify that the extrudate is compatible with the geomembrane and meets the requirements outlined in the Project Specification (02778)

Seaming

- The seam shall be overlapped a minimum of three inches
- The overlap shall be tack welded in such a manner not to damage the geomembrane
- Abrading shall be completed no more than one hour prior to seaming and shall not damage the geomembrane
- During tack welding and extrusion welding, the seam area will be free of dirt and other contaminants, i.e., moisture, hydrocarbon

- The extrusion welder will be purged, removing heat degraded extrudate, prior to seaming

**Fusion Wedge Welder**. The wedge welder shall be automated for movement and will be equipped for reading of applicable temperatures. Confirmation of the wedge temperature will be provided by a pyrometer. These readings shall be documented at appropriate intervals.

**Seaming**

- The seam overlap shall be a minimum of five inches
- The seam area will be free of dirt and other contaminants, i.e., moisture, hydrocarbon

**Trial Seams**. No technician or equipment will be permitted to seam before passing a trial seam. Trial seams shall be made at the beginning of each seaming period, equipment shut down, or when a significant change in ambient and/or equipment temperatures have taken place.

The trial sample shall be at least three feet long by one foot wide, with seam centered parallel to the width. The trial seam shall be conducted in the location of the installation.

Three strip samples (not adjoining), one inch wide, cut across the seam by the Installer shall be tested for peel and shear by electrically operated tensiometer. The test strip shall not fail in the seam. If a test strip fails, another trial seam will be attempted. In the event of another failure, the technician/equipment will not be permitted to seam until the deficiencies are corrected and a successful trial seam has been obtained.

The date, time, technician, equipment numbers, equipment temperature, ambient temperature (measured six inches above the geomembrane) and geomembrane temperatures will be documented. For extrusion welding, the extrudate temperature exiting from the nozzle, and for wedge welding, the wedge temperature shall be taken by pyrometer and documented.

In the event independent testing of the trial seam is required, a section of the trial seam (18 inches long) shall be retained and subjected to laboratory testing.

**General Seaming Requirements**. The seaming equipment temperatures, ambient temperatures and geomembrane surface temperatures shall be documented at regular intervals.

Panels shall be aligned in such a manner as to minimize the development of wrinkles/waves in the seam area.

If required, a firm substrate shall be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap.

Waves or wrinkles at the seam overlap, shall be cut along the ridge in order to achieve a flat overlay. The cut waves or wrinkles shall be seamed and any portion where the overlay is inadequate shall be patched with a patch of the same material extending a minimum of six inches beyond the cut in all directions.

If seaming operations are carried out at night, adequate illumination shall be required.

Seaming shall extend to the outside edge of panels to be placed in the anchor trench.

Butt seams require special treatment depending upon method of seaming, i.e., extrusion welding top seam is ground, beveled and seamed. For wedge welder, top and bottom of seam overlay is cut back to the seam, beveled, seamed, and as required extruded.

**Weather Conditions for Seaming.** The QC Personnel shall confirm that seaming is conducted only during weather conditions outlined the Project Specifications. In general, seaming will not proceed at ambient temperatures below 34°F or above 104°F.

**Non-destructive Seam Testing.** All equipment to be used for testing must have a trial demonstration and be approved prior to actual testing. The Installer shall non-destructively test all field seams over their full length using a vacuum test unit, air pressure test (for double fusion seams only), or other approved method. In the event the vacuum box is not gauged, it must be visually apparent that an adequate vacuum condition is maintained. The purpose of non-destructive tests is to check the continuity of seams, it does not provide any information on seam strength. Non-destructive testing shall be carried out as the seaming progresses, not at the completion of all field seaming.

The following procedures shall apply to locations where seams cannot be non-destructively tested:

- All such seams shall be cap-stripped with the same geomembrane
- If the seam is accessible to testing equipment prior to installation (fabrication), the seam shall be non-destructively tested prior to installation
- If the seam cannot be tested prior to installation, the seaming and cap-stripping operations shall be observed by the QC Personnel and Contractor for uniformity and completeness

The QC Personnel shall verify that all seam defects are identified, repaired, and retested in accordance with the procedures outlined in the Project Specification (02778).

**Destructive Seam Testing.** Destructive seam testing is an effort to evaluate seam strength. In order to provide maximum confidence, this testing can be applied as follows:

Individual Seams: At the beginning and the completion of a seam, a one inch wide strip sample, cut across the seam by the Installer, is removed from each location and field tested. Common sense must be applied when seam lengths are short. These test samples should, if possible, be removed from a location that would not require repairing.

Suspect Locations: In suspect locations, i.e., moisture or contamination, a one inch wide strip sample, cut across the seam by the Installer, is removed and field tested.

Laboratory Testing: Geosynthetics QA Laboratory sample locations are selected by the QC Personnel at a frequency averaging 500 feet of total seam length. The Installer shall not be informed in advance of the locations from which the samples are to be taken.

Alternatively, laboratory testing can be utilized to verify a site destructive seam testing program. Under this program the frequency/number of samples submitted to the laboratory will be determined by the Project Manager and QC Personnel. The frequency of site testing will be consistent with the requirements of the Project Specifications (average one test per 500 LF of seam).

**Laboratory Sampling**. Samples shall be cut by the Installer as the seaming progresses in order to have test results before the geomembrane is covered. All holes resulting form destructive seam sampling shall be immediately repaired in accordance with approved repair and testing procedures. The QC Personnel shall:

- Observe sample cutting
- Assign a number to each sample, and mark it accordingly, and
- Record sample location on the Record Drawing(s)

**Size of Sample**. The following procedures outline the method for obtaining the QA Laboratory sample.

First, two strip samples for field testing shall be taken. Each of these strip samples shall be 1-inch wide by 12 inches long, with seam centered parallel to the width. The distance between these two strip samples shall be 42 inches. If both strip samples pass the field test, a sample for QA Laboratory testing shall be taken.

The section between the two strip samples will be removed. The section shall be 12 inches wide by 42 inches long with the seam centered lengthwise. The section shall be cut into three parts and distributed as follows:

- One portion for QA Laboratory testing, 12 inches by 18 inches
- One portion to the Installer, 12 inches by 12 inches
- One portion to the Engineer for archive, 12 inches by 12 inches

**Field Testing**. The one inch wide strip samples shall be tested by electrically operated tensiometer, for peel and shear respectively, and shall not fail in the seam. If any test strip sample fails, then the procedures outlined in Section "Destructive Test Failure" shall be followed.

The QC Personnel shall witness field tests and, as required, mark all samples and portions with their number and document the locations, date and time, ambient temperature, equipment technician, seam number and test result.

**QA Laboratory Test Procedures**. The QA Laboratory shall be selected by the QC Personnel with the approval of the Resident Engineer. The shipping of the samples shall be the responsibility of the QC Personnel.

Test samples shall be forwarded to the Geosynthetics Quality Assurance Testing Laboratory or they will be tested on-site using a portable tensile testing machine. Tests shall include "Seam Strength" and "Peel Adhesion" (ASTM D638).

The minimum acceptable values are outlined in the Project Specifications. Ten specimens shall be used, fifteen for dual-tracked fusion welds. Specimens shall be selected alternately from the samples (i.e., peel, shear, peel, shear...).

The QA Laboratory shall provide test results no more than 24 hours after they receive the samples. The QC Personnel shall review test results as soon as they become available, and make appropriate recommendations to the Engineer and Installer.

**Destructive Test Failure**. The following shall apply whenever a laboratory sample or field test strip fails. The Installer has two options:

- The Installer can reconstruct the seam between any two locations which were previously tested and rejected, and retest.
- The Installer can trace the seam in both directions to locations 10 feet from the location of the failure. Test strip samples are then taken in both locations for field testing. If these pass, full laboratory samples are removed. If the laboratory samples pass, then the seam is reconstructed, and non-destructively tested between the passing locations. If either sample fails, then the procedure is repeated.

Repairs

All seams and non-seam areas of the geomembrane shall be examined by the QC Personnel to identify defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of examination. Each location requiring repair shall be marked by the QC Personnel and repaired by the Installer.

**Repair Procedures**. The repair procedure shall be agreed upon by the Resident Engineer, Installer and QC Personnel. The procedures include:

- Patching: to repair large holes, tears, undispersed raw materials, and contamination by foreign matter
- Spot extrude: to repair, pinholes, or other minor flaws (i.e., scratches, crimps)
- Capping: to repair large lengths of failed seams
- Topping (extrude capping): to repair inadequate seams, which have an exposed edge and the geomembrane has not been damaged by prior seaming, and
- Removing the seam and replacing with a field strip of new material

In addition, the following shall be satisfied:

- Surfaces of the geomembrane to be extrudate repaired shall be abraded no more than one hour prior to the repair
- All surfaces must be clean and dry at the time of the repair
- Patches or caps shall extend at least six inches beyond the edge of the defect, and all corners of patches shall be rounded, and
- The geomembrane below large caps/patches should be cut to avoid water or gas collection between the two sheets

**Testing**. Each large cap/patch shall be numbered and documented. Every repair shall be documented and non-destructively tested. Large caps may, at the discretion of the QC Personnel, require destructive seam testing. The QC Personnel shall observe and document testing of repairs.

**Waves/Wrinkles**. When installation of the geomembrane is completed (or when seaming of a large area is completed) and prior to placing overlying materials, the QC Personnel shall observe the waves/wrinkles. The QC Personnel shall indicate to the Installer which waves/wrinkles should be corrected. The corrective measures shall be tested like any other repair.

**Bridging**. The QC Personnel will observe areas where the geomembrane is bridging. He will evaluate with the Installer/Engineer whether corrective measures are required. Corrective measures shall be tested as any other repair.

Backfilling of Anchor Trench

The anchor trench shall be adequately drained, to prevent ponding or otherwise softening of soils while the trench is open. The anchor trench shall be backfilled as directed by the Engineer and as shown in the Drawings. Care shall be taken when backfilling to prevent damage to the geosynthetics. The QC Personnel shall observe the backfilling operation and advise the Installer/Engineer of any problems.

Geosynthetic Membrane Liner Acceptance

The Installer and the Manufacturer shall retain Ownership and responsibility for the geosynthetic membrane in the lining system until acceptance by The Group.

The geosynthetic membrane liner shall be accepted by The Group when:

- The installation is completed
- Verification that seams and repairs, including associated testing, is complete, and
- All documentation of the installation is completed including the Record Drawings, and Final Report

The QC Personnel shall certify that the installation has proceeded in accordance with the Project Specifications, except as reported to the Engineer.

Materials in Contact with the Geomembrane

The CQA procedures in this section are to provide assurance that the installation of these materials does not damage the lining system.

**Soils**. The QC Personnel shall verify that the soils meet the minimum requirements of the Project Specifications.

- Placement of soils on the geosynthetic membrane shall not proceed at an ambient temperature below 34° F nor above 104°F unless otherwise specified. Temperature is taken 6 inches above the geomembrane.
- Equipment used for placing soil shall not be driven directly on the geosynthetic membrane.
- A minimum thickness of one foot of soil is required between a light dozer (such as a wide pad caterpillar D-3 or lighter) and the geosynthetic membrane.

- A minimum thickness of two feet of soil is required between rubber-tired vehicles and the flexible membrane liner.
- In heavily trafficked areas such as access ramps, soil thickness should be at least three feet.
- Verify soil thickness
- Verify that placement of soil is done in such a manner that lining system damage is unlikely

### 4.5.4 Drainage Net

Drainage net consisting of a inner woven HDPE core with heat bonded nonwoven needle-punched geotextile heat bonded to both sides. The QC personnel shall be responsible for recording the following items prior to installation of the drainage net:

- Name and location of manufacturer
- Date of receipt of delivery at job-site
- Roll number and batch number of drainage net

The QC Personnel shall observe and document the following items during the placement of the drainage net on completed and approved areas of the underlying geomembrane:

- On sideslopes the drainage net shall be securely anchored, and then rolled down the slope in such a manner as to continually keep the drainage net in tension. If necessary, the drainage net shall be positioned by hand after being unrolled to minimize wrinkles.
- In the presence of winds, all drainage net shall be secured by suitable methods. The temporary weighted material will be left in place until replaced with cover material as shown on the design plans and specifications.
- Cutting of the drainage net shall be done in accordance with the manufacturer's recommendations.
- The Contractor shall take all necessary precautions to prevent damage to the underlying geomembrane during the placement of the drainage net.
- During the placement of the drainage net, care shall be taken to prevent entrapment of any stones, excessive dust, or moisture that could cause clogging of the drainage system, and/or stones that could damage the underlying geomembrane.

The drainage net will arrive at the job-site in rolls that will need to be overlapped and joined in the field during the placement activities. The following requirements pertain to the QC Personnel's involvement during these activities:

- Adjacent rolls will be overlapped a minimum of four (4) inches.
- Overlaps will be secured by tying the separate panels to each other.

- Tying is to be achieved by strings, plastic fasteners, or polymer braid. Tying devices will be white or brightly colored for easy identification. These devices must not have any sharp points or edges that could potentially damage the underlying geomembrane.
- Geotextile on the top layer of the drainage net shall be sewn onto the adjacent panel at all seams as per the recommended by the manufacturer.

QC Personnel shall perform a final inspection of the completed drainage net area for presence of tears or defects as well as proper seaming of the geotextile. If an area is not acceptable due to material or workmanship, the affected area shall be removed by the Contractor and repaired to the satisfaction of the QC Personnel.

### 4.5.5 Cover Soil Layer

The Cover Soil Layer shall consist of on-site granular soil materials as described in Section 02220 of the Project Specifications. A minimum uniform layer of 18 inches of Cover Soil fill will be placed over the geomembrane.

Placement of the Cover Soil Layer shall conform to the standards outlined in Section 02778 (Geomembrane) of the Project Specifications. This section outlines minimum working lift thicknesses for the equipment used to place the Cover Soil material to prevent tearing or puncture of the underlying geomembrane. The work shall be coordinated with the placement of the drainage net on top of the geomembrane.

The QC personnel shall observe and document placement operations by the Contractor and monitor such things as working lift thickness, type of equipment used for placement and final Cover Soil Layer thickness. QC personnel shall sample according to the frequency outlined below.

**COVER SOIL LAYER CONSTRUCTION TESTING**

| Test Description | ASTM Designation | Minimum Test Frequency |
|---|---|---|
| Visual Soil Classification | D2488-90 | One (1) test per 2,500 cubic yards or one (1) test per acre |
| Grain Size Distribution | D1140-54 | One (1) test per 2,500 cubic yards or one (1) test per acre |

The finished surface of the Cover Soil Layer shall be surveyed by the Contractor on the same grid pattern as for the Gas Collection/FoundationLayer. The Contractor will provide the survey information to the QC personnel in digital format as record documentation data.

### 4.5.6 Type 1 Drainage Material

Type 1 drain material is a coarse sand and gravel used in a four (4) foot zone on either side of the drainage tubing in the stormwater control berm flowlines. Prior to placing the material, it will be tested by the Contractor as outlined below.

**TYPE 1 DRAINAGE MATERIAL PRE-CERTIFICATION TESTS**

| Test Description | ASTM Designation | Minimum Test Frequency |
|---|---|---|
| Grain Size Distribution | C136 & C117 | 3 tests per source |
| Soundness | C88 | 3 tests per source |

The drain material shall be placed by the Contractor using methods as defined in Section 02220 of the Project Specifications and in accordance with the configurations shown in the Drawings.

The construction documentation report shall include the pre-certification reports and photographic documentation of pertinent construction and sampling activities.

### 4.5.7 Topsoil

Prior to spreading topsoil, the Contractor will submit test data from 3 source samples demonstrating compliance with the Project Specification (02220). A minimum of one representative sample per acre shall be analyzed by the Contractor for compliance with the requirements outlined below.

**REQUIREMENTS FOR TOPSOIL**

| Property | Minimum | Maximum |
|---|---|---|
| Material passing #10 sieve | 90% | NA |
| Clay | 5% | 30% |
| Silt | 10% | 70% |
| Sand & Gravel | 20% | 70% |
| Organic Matter | 4% | 20% |
| pH | 6.1 | 7.5 |
| Extractable Phosphorous | 30 lbs/Acre | -- |
| Exchangeable Potassium | 150 lbs/Acre | -- |
| Nitrogen | | -- |

The thickness of the topsoil layer will be documented by the QC personnel by coring through the finished layer with a hand auger or similar device and measuring the thickness. Thickness measurements shall be made on a 100 foot grid pattern. A minimum thickness of 6 inches will be required at all locations.

### 4.5.8 Seeding

The seeding involves preparation of subsoil, fertilizing and maintenance. The vegetation requirements are included in Section 02936 of Appendix E.

### 4.5.9 Stormwater Control System

The stormwater control system will involve the construction of drainage net stormwater control berms, drainage flow lines and reinforced concrete pipe (RCP). These items are presented in the following sections and the required inspections outlined.

#### *Underdrain System*

The core of the stormwater control berm shall be constructed of the same material as the Cover Soil Layer. Material properties tests, test reports and quality control certificates for the filter fabric material will be provided prior to installation. QC Personnel will visually observe the placement of bedding materials, placement of the drainage tubing, installation of filter fabric, and backfilling operations. The QC Personnel shall inspect the orientation of the geomembrane flap after placement of the geotextile, drainage tubing and backfill of the subdrain system to ensure the configuration shown in the Drawings.

#### *Reinforced Concrete Pipe (RCP)*

Excavation for the placement of RCP shall be in compliance with all applicable OSHA regulations with the excavation side slopes not to exceed 1 (vertical) to 1 (horizontal). Pipe placement shall be done to ensure all seals between the sections are properly seated in the pipe joint. Pipe grades and alignment shall be verified by the Contractor upon completion of the pipe placement and prior to backfilling. The constructed grades shall be within 0.1 foot of the design elevations and grades shown on the Drawings. The Contractor will provide the survey information to the QC personnel in digital format as record documentation data.

The QA Officer, or his designee, shall confirm that all CQA requirements have been addressed and provide the Resident Engineer with signed descriptive remarks, memorandums, data sheets, and checklists to confirm that all monitoring activities have been completed. The QA Officer will maintain a current CQAP, checklists, test procedures, daily logs, and other pertinent documents. The Resident Engineer shall be responsible for the on-site maintenance of a complete specifications manual indicating the construction QA/QC requirements of the work. QC Personnel shall maintain records of all QC testing and inspectors and make the records available for audit by the QA officer.

Several inspection and test reporting forms which may be used by QC Personnel or the QA Officer to facilitate CQA reporting are presented in Appendix A.

## 5.1 DAILY SUMMARIES

The QC Personnel or Resident Engineer shall complete a daily QA/QC report summarizing construction QA/QC activities for the day. This report will be completed by the following day after the work and submitted to the Resident Engineer. Any matter requiring action by the Resident Engineer shall be highlighted. The daily QA/QC report will, at a minimum, include: (a) field notes; including memorandum of meetings and/or discussions, (b) observation and testing data sheets, (c) QC observation and testing data sheets, and (d) construction problem and solution data sheets.

### 5.1.1 Observation and Testing Data Sheets

The Contractor will assist QC Personnel in preparing the daily QA/QC report by providing a daily report to the QC Personnel. The daily report will, at a minimum, include: (a) Quality Control personnel field notes; including memorandum of meetings and/or discussions, and (b) QC Observation and Testing data sheets. Observation and testing data sheets will typically include the following information:

- Identifying sheet number for cross referencing and document control
- Date, project name, location, and other identification
- Weather conditions
- A reduced-scale Site Plan showing all work areas
- Equipment and personnel in each work area, including subcontractor(s)
- Descriptions and specific locations of work being tested and/or observed
- Locations where tests and samples were taken
- Summary of test results
- Calibration or recalibration of test equipment
- Materials received, including QC documentation
- Identification of the panels/seams completed and approved, and measures taken to protect unfinished areas

- Identification of seams or panel areas requiring repairs
- Identification of repairs completed
- Decisions regarding acceptance of work and/or corrective actions taken in instances of substandard quality, and
- QC Personnel signature

Items above should be organized on log sheets so that none are overlooked. Sample sheets are included in Attachment A.

### 5.1.2 Problems, Deficiencies and Corrective Measures

The QA Officer will document construction problems, deficiencies, and solutions discussed in Progress Meetings (Specification 01039). These memorandum shall be cross-referenced with associated CQC observation and testing data sheets prepared by the QC Personnel, and must include the following information, as applicable:

- Identifying number for cross-referencing and document control
- Detailed description of the problem or deficiency
- The location and probable cause of the problem or deficiency
- How and when the problem or deficiency was found or located
- Documentation of the response(s)
- Final results of any response(s)
- Measures taken to prevent a similar situation from occurring in the future
- The signature of the QA Officer/QC Personnel and Engineer indicating concurrence

These memorandum and all supporting data sheets, along with test results and the QA Officer's approval of the work, must be compiled by the QA Officer. These documents shall be included in the Final Certification Report prepared by the Resident Engineer and QA Officer upon completion of construction.

## 5.2 DESTRUCTIVE TEST REPORTS

The destructive test reports from all sources shall be collated by the QA Officer, or his/her designee. This includes field tests, Product data sheets, Installer's laboratory tests, and Geosynthetics QC Laboratory tests. A log of test sample results will be maintained by the QC Personnel on an ongoing basis, and submitted with the progress reports.

## 5.3 PHOTOGRAPHIC REPORTING FORMS

Photographic reporting shall be cross-referenced with Observation and Test Data sheet(s) and/or construction problem and solution data sheet(s). These photographs will serve as a pictorial record of work progress, problems, and mitigating activities. The basic file will contain color prints; negatives will also be stored in a separate file in chronological order. These records shall be presented to the Resident Engineer upon completion of the project.

## 5.4 DESIGN AND/OR SPECIFICATION CHANGES

Design and/or specification changes may be required during construction. Design and/or specification changes shall be made only with written agreement of the Engineer and The Group, and shall take the form of an addendum to the Contract Documents.

## 5.5 PROGRESS REPORTS

The Resident Engineer or his designee shall prepare a progress report once every two weeks during construction, or at time intervals established at the pre-construction meeting. As a minimum, this report shall include the following information:

- Identifying number for cross-referencing and document control.
- The date, project name, location, and other information.
- Summary of work activities during progress reporting period.
- Summary of construction problems, deficiencies.
- Summary of weather conditions.
- Brief description of activities anticipated for the next reporting period.
- Signature of the Resident Engineer.

## 5.6 RECORD DRAWINGS

Record/As-Built construction drawings will be prepared by the Contractor's surveyor under the direction of the Engineer and reviewed by the Surveyor. At a minimum, the drawings should include the following information:

- Top dimensions of designated layer(s) of soil with spot elevations.
- Location and details of the earthwork construction including depths, plan dimensions, elevations, soil components thickness', etc.

The Drawings shall address each of the construction components and, if necessary, additional drawings shall be used to identify problems or unusual conditions of the geotextile layers. In addition, applicable cross-sections shall show layouts of components which differ from the specifications.

## 5.7 FINAL AND SUMMARY REPORT

A CQA Final Report shall be submitted upon completion of the work and will include all documents prepared or compiled by the QA Officer. This report shall summarize the construction QA/QC activities of the project and the documentation for all aspects of the CQA plan performed. The CQA Final Certification Report will become a part of the Remedial Action Implementation Report and shall include as a minimum the following information:

- Personnel involved with the project.
- Scope of work.
- Outline of project.
- QA/QC methods (if different than specified).
- Test results (destructive and non-destructive, including laboratory tests).
- Certification sealed and signed by a registered professional engineer.
- Record Drawings, sealed and signed by a registered professional engineer.

The summary report that is prepared by the QA Officer shall also verify that construction was completed in compliance with the project drawings, the specifications and the CQAP. The CQC Personnel will assist the QA Officer as necessary to compile QC Observation and Testing Data reports, Manufacturer's QC certification forms, and other related information. The report shall be prepared under and signed by a registered Professional Engineer and The Group's Project Coordinator.

## 5.8 STORAGE OF RECORDS

All original records, especially those containing signatures, will be stored by the Engineer in a safe repository on site. Other reports may be stored by any standard method which will allow for easy access.

# ATTACHMENTS

A

D

APPENDIX D
FINAL REPORT

# DRAFT OPERATION AND MAINTENANCE PLAN ALBION SHERIDAN TOWNSHIP LANDFILL CALHOUN COUNTY, MI

*Prepared for*
Cooper Industries
Houston Texas

and

Corning, Inc.
Corning, New York

August, 1997

Woodward-Clyde

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Livonia, Michigan 48151
6E13045

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## Tables



## Figures



## Attachments

This draft Operation and Maintenance (O&M) Plan was prepared by Woodward-Clyde Consultants (WCC) for Corning, Inc. and Cooper Industries (the Group) to describe the implementation and long-term maintenance of the remedial actions at the Albion-Sheridan Township Landfill (ASTL). This plan has been prepared in accordance with the guidelines set forth in the Unilateral Administrative Order (UAO) prepared for this site (U.S. EPA, October 1995). The information presented in Section 1 was derived from the Remedial Investigation Report (WW Engineering and Science, April, 1994), the ROD and SOW. A final O&M Plan will be submitted prior to the Prefinal Construction Inspection, in accordance with the approved construction schedule.

## 1.1 PURPOSE

This O&M Plan establishes project-specific instructions for managing specific post-closure work required to comply with the federal and state provisions for the long-term post-closure care for the landfill cover.

## 1.2 DOCUMENT ORGANIZATION

This document has been organized into the following seven sections:

| | |
|---|---|
| Section 1.0 | Introduction - provides the basis, organization and site background |
| Section 2.0 | Description of Remedial Action - summarizes the remedial action components |
| Section 3.0 | Operations - details project-specific instructions for managing post-closure work |
| Section 4.0 | Maintenance - same as operations |
| Section 5.0 | Description of Operation and Maintenance Equipment - describes O&M equipment requirements |
| Section 6.0 | Operation and Maintenance Key Personnel Responsibilities - describes responsibilities of key O&M personnel |
| Section 7.0 | References - presents document references |

## 1.3 SITE LOCATION AND DESCRIPTION

The ASTL is an inactive landfill located at 29975 East Erie Road approximately one mile east of Albion, Michigan on the eastern edge of Calhoun County (Figure 1). The site occupies approximately 18 acres. The site is surrounded by a combination of residential, agricultural, commercial and industrial properties. One residence is located immediately adjacent to the landfill to the south and five additional residences are located approximately 1,000 to 1,500 feet (ft) southwest of the landfill along East Erie Road. An active railroad track borders East Erie Road to the south of the landfill, and beyond the railroad tracks lies the North Branch of the Kalamazoo River. South of the river is agricultural land. The site does not fall within the flood plain of the river. There are wetlands south of the site adjacent to the river, but are not expected to be impacted by site activities.

The Amberton Village housing development is located adjacent to the site on the east side, with the closest residences approximately 500 ft from the landfill. Several residences and commercial businesses are located along Michigan Avenue approximately 500 ft north of the site. Immediately west of the site is undeveloped land formerly used for agriculture. The Orchard Knoll subdivision is located approximately 1,500 ft northwest of the landfill. Approximately 2,000 ft northwest of the site is a landfill associated with Brooks Foundry. Approximately one mile west is the city of Albion, with a population of 10,066 according to the 1990 census. This figure does not include approximately 1,700 students enrolled at Albion College located in the City of Albion.

## 1.4 GENERAL LICENSE INFORMATION AND REGULATORY STATUS

From 1966 to 1981, the landfill was privately owned and operated by Mr. Gordon Stevick. The landfill accepted municipal refuse and industrial wastes from households and industries in the City of Albion and nearby townships. In the early 1970s, the Michigan Department of Natural Resources (MDNR) approved the landfill to accept metal plating sludges. The landfill ceased operation in 1981.

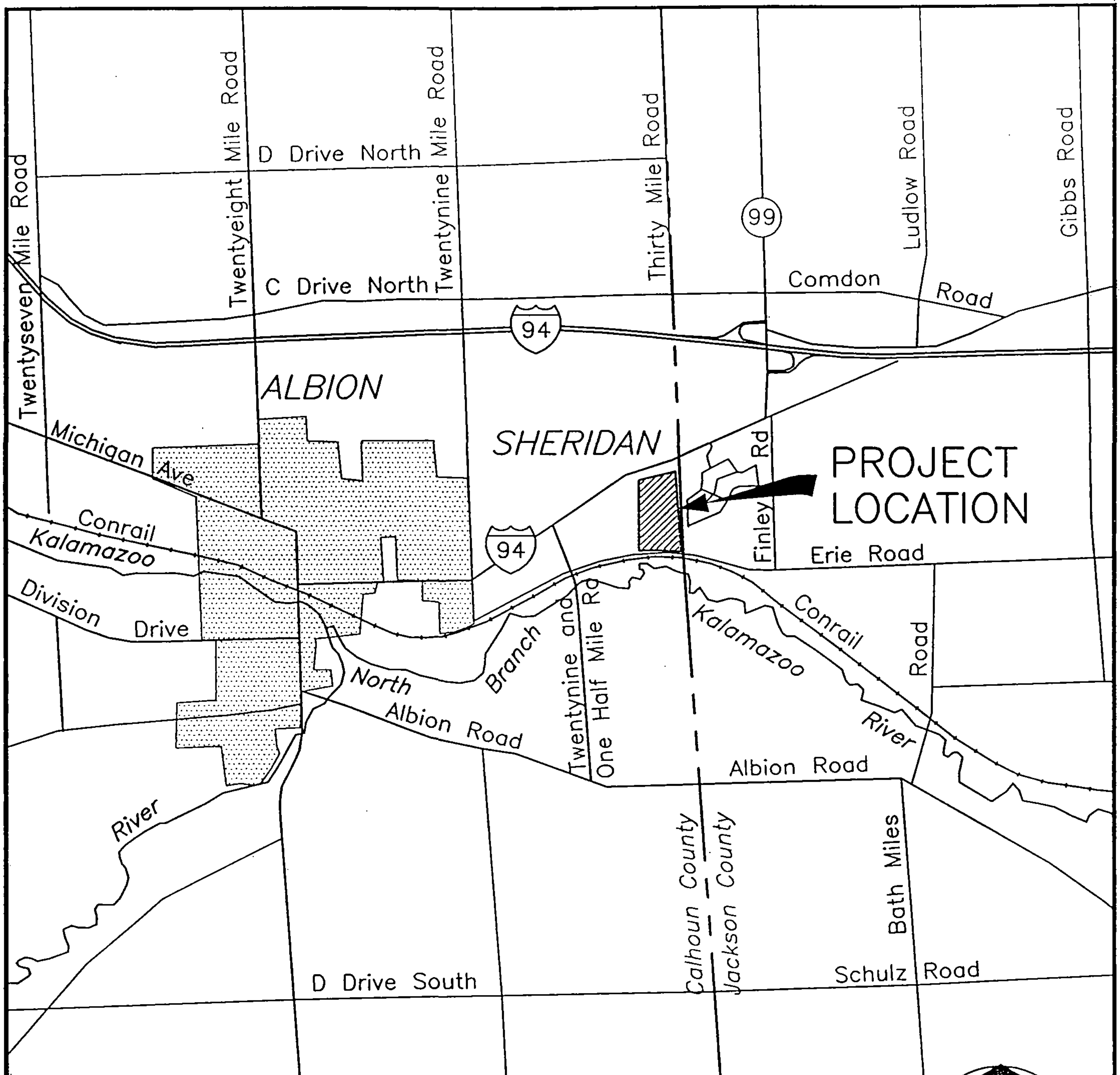
In 1986, a United States Environmental Protection Agency (U.S. EPA) Field Investigation Team contractor performed a Site Screening Inspection for purposes of scoring the site per the Hazard Ranking System (HRS). EPA listed the site on the National Priorities List (NPL) in 1989. In 1991, the site was selected as a demonstration site for the presumptive remedy for CERCLA municipal landfill sites. The U.S. EPA completed a Remedial Investigation (RI - WWES, 1994) report in April 1994. A Record of Decision (ROD), defining the required remedial action for the site, was signed by the Regional Administrator of U.S. EPA Region V on March 28, 1995. Respondents declined to enter into a consent decree to conduct the RD/RA for the site in accordance with the ROD and SOW, so the U.S. EPA issued an UAO on October 11, 1995.

## 1.5 SITE HISTORY

The Albion-Sheridan Township Landfill Site had been used as a sand and gravel borrow pit and also used for open, unpermitted dumping for an unspecified period of time prior to 1966. From 1966 to 1981, the landfill was privately owned and operated by Mr. Gordon Stevick. The landfill accepted municipal refuse and industrial wastes from households and industries in the City of Albion and nearby townships. In the early 1970s, the Michigan Department of Natural Resources (MDNR) approved the landfill to accept an estimated 6,000 cubic yards of metal plating sludges. Other materials, such as paint wastes and thinners, oil and grease, and dust, sand, and dirt containing fly ash and casting sand were also disposed of at the site. The sludge remain buried at the site. The landfill ceased operation in 1981.

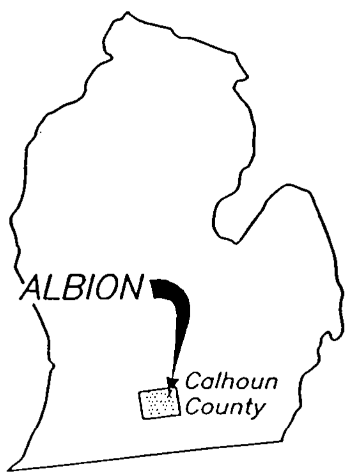
## 1.6 SITE GEOLOGY

As documented in the RI, the geology of the site is characterized by approximately 20 to 54 ft thick glacial sediments overlying sedimentary bedrock (Figure 2). The glacial sediments consist of outwash sands and till, while the bedrock consists of fractured sandstone of the Marshall Formation.




VICINITY MAP

NOT TO SCALE



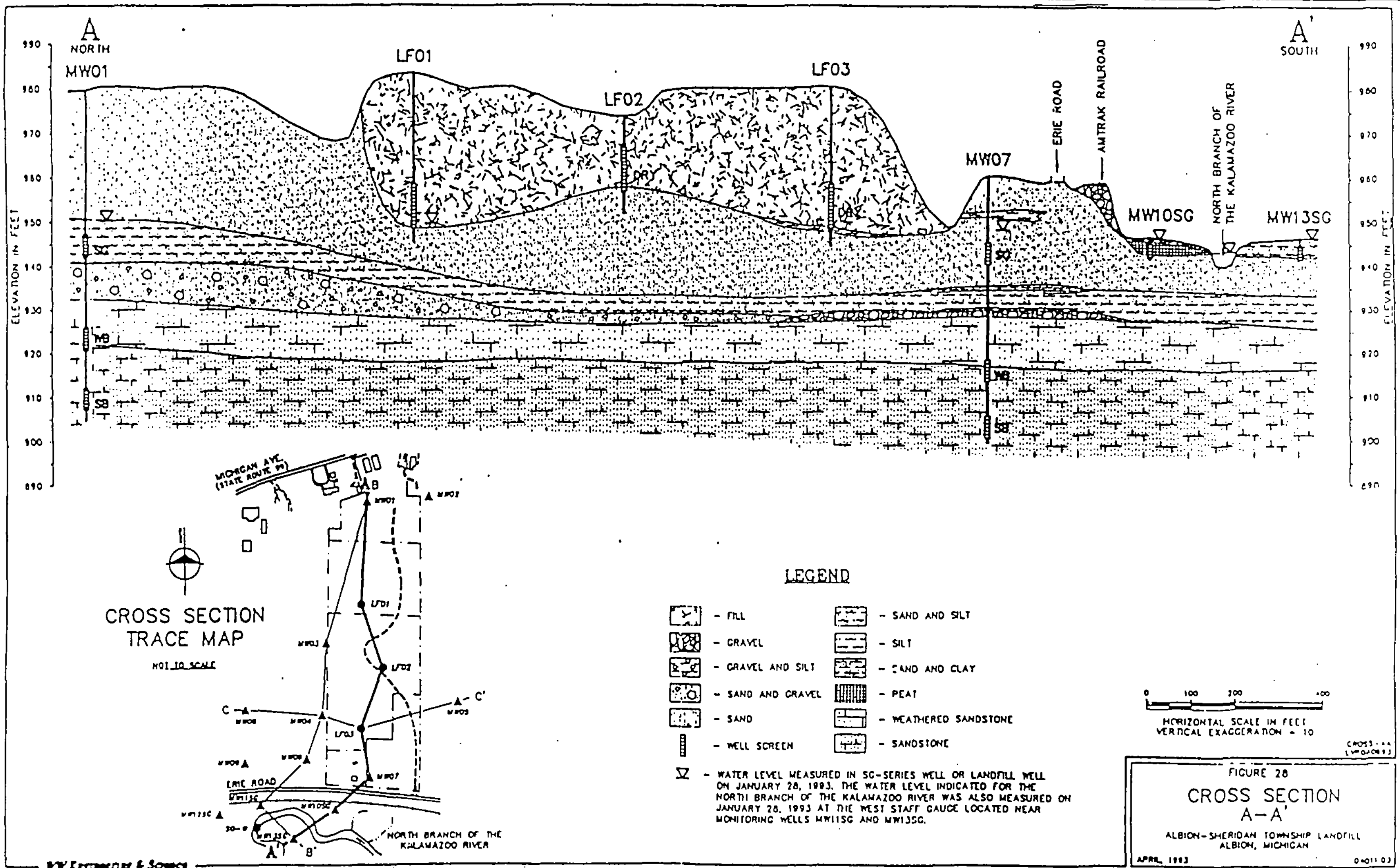

ALBION–SHERIDAN TOWNSHIP LANDFILL
ALBION, MICHIGAN

**Woodward-Clyde Consultants**

ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS

SITE LOCATION MAP

| | | | |
|---|---|---|---|
| DRN BY: KAH | DATE: MAY 1997 | PROJECT NO. | FIG. NO. |
| CHK'D BY: DS | DATE: MAY 1997 | 6E13045 | 1 |

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CROSS–SECTION MAP FROM W.W. ENGINEERING & SCIENCE

| | | | |
|---|---|---|---|
| DRN BY: KAH | DATE: APR. 1997 | PROJECT NO. | FIG. NO. |
| CHK'D BY: DS | DATE: APR. 1997 | 6E13045 | 2 |

Generally, the uppermost portion is composed of outwash sand from the ground surface to a depth of 10 to 30 ft below ground surface. Beneath the outwash sand is a glacial till composed primarily of silty sand with discontinuous layers containing silt and/or clay. There are no obvious clay confining layers beneath the site that are extensive enough to effectively hydraulically isolate the landfill materials from bedrock groundwater.

The uppermost bedrock beneath the site is comprised of Mississippian-aged sandstone of the Marshall Formation. The top bedrock beneath the site is generally encountered at an elevation of approximately 935 to 925 feet mean sea level (MSL). The uppermost portion of the sandstone (generally the upper 5 to 25 feet) is intensively weathered and very weak. Beneath the weathered portion, the rock is more competent and better cemented; however, it is still highly fractured. The sandstone is characterized by very fine to fine-grained quartz containing trace amounts of pyrite, mica and coal.

## 1.7 HYDROGEOLOGY

The results of the RI found groundwater beneath the site to be contained within the unconsolidated and bedrock aquifers. The two units are hydraulically connected in the vicinity of the site as evidenced by water level elevations. In addition, no significant clay layers or aquicludes were encountered during the drilling.

Groundwater was encountered in the unconsolidated unit throughout the site at depths of 10 to 30 feet below ground surface. Groundwater was at or very near the ground surface at the well locations adjacent to the North Branch of the Kalamazoo River. The occurrence of shallow groundwater at the site is controlled primarily by infiltration of precipitation and the characteristics of the unconsolidated unit.

The direction of groundwater flow in the unconsolidated unit is west-southwest in the vicinity of the landfill and curves in a more southerly direction near the North Branch of the Kalamazoo River. The average hydraulic conductivity of this unit was determined during the RI to be 29 ft/day. The groundwater flow velocity in the unconsolidated unit was calculated to be approximately 0.29 ft/day or 106 ft/yr.

Comparing the water level data from both bedrock wells and unconsolidated wells indicates there is a vertical component to groundwater flow. The vertical component of groundwater flow is generally downward in the northern part of the site and upward south of the site near the river. The downward gradient suggests that the northern portion of the site is an area of groundwater recharge, and the upward gradient south of the site is consistent with groundwater discharging to the North Branch of the Kalamazoo River. In addition, there is an upward gradient in the MW04 well between the deep bedrock and the shallow bedrock. This indicates that the groundwater in the deep bedrock is discharging to the shallow and weathered bedrock aquifers, thus helping to protect the deeper groundwater from contamination.

The results of the Pre-Design Studies indicated that overall, groundwater flow characteristics in the unconsolidated and bedrock units (flow direction, gradient, groundwater flow velocity) were similar with values reported in the RI.

## 1.8 CONTAMINANTS OF CONCERN

Waste samples from borings contained numerous constituents, including 10 VOCs, 19 semi-volatile organic compounds (SVOCs), and 11 pesticides/PCBs. Several inorganic substances were present above background levels in subsurface soils, including antimony, arsenic, chromium, copper, lead, mercury and zinc. The highest concentrations include lead at 208 mg/kg, arsenic at 13.1 mg/kg and chromium at 13.5 mg/kg. Toxicity Characteristic Leachate Procedure (TCLP) metals analysis results indicated the presence of barium and lead in the leachate, both below hazardous waste levels.

The RI found landfill constituents in groundwater extending southwest of the landfill for approximately 900 ft and extending vertically to a depth of approximately 45 ft below the water table. The unconsolidated aquifer plume contained 1,2-dibromo-3-chloropropane and antimony at concentrations above their respective federal Maximum Contaminant Level (MCL). The bedrock aquifer plume contained vinyl chloride at the MCL and arsenic above the MCL, at concentrations up to 126 ug/l.

The results of the Pre-Design Studies indicated that overall, shallow glacial monitoring well samples exhibited similar results as those obtained during the RI. The only organic compounds detected included vinyl chloride (MW03SG at 1.0 µg/L), chloroethane (MW07SG at 1.0 µg/L) and bis (2-Ethylhexyl) phthalate (MW05SG at 6.4 µg/L). Arsenic was detected in 2 wells, MW04SG and MW07SG, at concentrations of 7.9 µg/L and 13.2 µg/L, respectively.

The results of the Pre-Design Studies also indicated that overall, bedrock monitoring well samples exhibited similar results as those obtained during the RI. There were no VOCs or SVOCs detected. The only inorganic analyte detected above the 50 µg/L MCL was Arsenic in MW06SB at 130 µg/L.

## 1.9 WASTE CHARACTERISTICS

The landfill is currently covered with a 1 to 4 feet thick layer of silty sand with some gravel. The cover thickness averages approximately two feet. Refuse is present within the cover material at some locations, and includes sludge, glass fragments and insulation. Refuse material is scattered at the ground surface throughout the landfill, particularly on the slopes; this material includes metal, plastic, concrete, asphalt, 55 gallon drums, wood, tires, a storage tank, and a junk crane. The landfill surface is currently subsiding at rates of 0.04 ft to 0.13 ft per year.

The landfill ranges from 16 to 35 ft thick. During drilling of wells, refuse interlayered with medium to fine sand was encountered. Landfill gases at concentrations greater than 10,000 ppm were encountered during the installation of wells and subsidence monuments on the landfill. Subsurface samples contained up to 1,500 ppm total VOCs.

The landfill cap will cover the entire landfilled waste mass indicated in the ROD and refined during the Pre-Design Studies (WCC, 1996). The landfill cap will meet or exceed the substantive requirements of RCRA subtitle D (40 CFR Part 241) and any more stringent requirements of Michigan NREPA 451, 1994 Part 115 which are applicable or relevant and appropriate to the site as determined by the U.S. EPA. The multi-layer landfill cover design at a minimum will include (from the surface downward):

- Vegetative Cover: Native plant species will be used to establish a vegetative cover to control erosion.
- Topsoil Layer: The topsoil layer, which is a minimum of 6 inches (in) thick, will be placed to sustain plant growth, control erosion and promote drainage.
- Cover Soil Layer: The cover soil layer will be 18-in thick.
- Drainage Layer: The drainage layer will consist of a synthetic material (geonet) with a transmissivity of at least $3 \times 10^{-5}$ $m^2$/sec.
- Flexible Membrane Liner (FML): The FML will be equivalent to or less permeable than a 40 mil low density polyethylene (LDPE), or 30 mil polyvinyl chloride (PVC).
- Gas Collection Layer: The gas collection layer will consist of a 12-in. thick sand layer on top of the existing waste mass.

The following components were identified in the SOW as parts of the construction and installation activity of the landfill cap:

- A permanent fence shall be installed and maintained at the site to prevent access and vandalism to the site.
- Test pit area TP09 shall be excavated to uncover all drums. Drummed wastes are to be characterized and properly disposed of either off-site or under the cap
- Consolidating the waste on the east edge of the landfill towards the west so that the east boundary of the landfill cap and any perimeter road needed for maintenance is contained on lot 28.
- Consolidating the waste on the south edge of the landfill so that the south boundary of the landfill cap and any perimeter road needed for maintenance is contained in lot 28, parcel 3, and parcel 2 north of a line extending to the east from the north boundary of parcel 1. If lot 28 parcels 1 and 2 are acquired, waste consolidation of the south edge will not be necessary.
- Grading the landfill to attain grades and slopes required to facilitate drainage and to meet ARARs. Regrading may be used to achieve sub-cap contours. Off-site clean fill can only be employed for grading with prior EPA approval. WCC proposed waste consolidation from the east edge of the landfill to assist in achieving the sub-cap contours.
- Abandoning (pull casing and seal with grout), prior to construction of cap, monitoring wells LF01, LF02, and LF03.

- Closing and abandoning, prior to pre-final construction inspection, monitoring wells MW-West, MW-South and MW-East. All well abandonment and closure shall be in accordance with Michigan Act 315, The Mineral Well Act of 1969.
- Empty storage tanks and abandoned machinery located on the surface of the landfill will either be incorporated into the landfill or transported to off-site facilities for recycling or disposal.

The remedy includes two monitoring systems:

1) Passive Gas Collection and Venting System: comprised of vertical vents which are connected to horizontal perforated piping with a gas collection soil layer. The gas venting system will be monitored to evaluate the character of the landfill gas.
2) Groundwater Monitoring System: comprised of groundwater monitoring wells and residential wells that will be used to monitor the impact of the landfill on the groundwater quality.

Operations at the site include groundwater and gas venting system monitoring, reporting and recordkeeping of site inspections and reporting. All operations will comply with the requirements for health and safety to be detailed in the O&M contractors site-specific HASP.

Monitoring at the Site includes sampling groundwater monitoring and residential wells on a quarterly and annual basis for laboratory analysis to evaluate groundwater levels and quality, and air monitoring of the passive gas venting system to evaluate the concentration of methane emanating from the landfill.

## 3.1 GROUNDWATER MONITORING MODIFICATIONS

As stated in the Pre-Design Studies Report (WCC, 1996), MW15SB and MW09DB were unable to be installed. WCC suggests that the installation of these two wells be coordinated with the monitoring well abandonment requirements (LF01, LF02, LF03, MW-West, MW-South and MW-East). Installation of MW15SB and MW09DB will be according to the procedures approved in the Remedial Design Work Plan (WCC, June, 1996). SOP-01 and SOP-02 have been retained in Attachment A to document the monitoring well installation and development procedures. The monitoring of MW15SB and MW09DB can then be incorporated into the performance monitoring program.

During a July 7, 1997 conference call between Robert Gibson (WCC), Jon Peterson (EPA) and Kim Sakowski (MDEQ) it was agreed to install MW09DB 200 feet west of the MW16 cluster and MW15SB 200 feet east of the MW16 cluster. The MDEQ requested the change in monitoring well locations to monitor the Groundwater Surface Water Interface (GSI) exceedances of arsenic and cadmium at MW06SB. It was also agreed to install the wells so the screen straddles the weathered bedrock/shallow bedrock interface. MW09DB would then be referenced as MW09DB (SB).

The Group proposes proper abandonment of MW11SG because the upgradient monitoring network will detect changes in groundwater constituents prior to reaching this surficial water table monitoring point and as reported in the Pre-Design Studies Report (WCC, 1996), the well has been vandalized (completely removed from the ground).

The Group also proposes to properly abandon MW13SG since this surficial water table monitoring well is on the south side of the North Branch of the Kalamazoo River in an upgradient position and is in a very inaccessible location.

The purpose of the long-term O&M groundwater monitoring is to assess the effectiveness of the remedial action/cap integrity by detecting changes in the chemical concentration of the groundwater at and adjacent to the site. Additionally, the integrity of each well will be assessed during each sampling event. The O&M groundwater monitoring program is detailed below. This plan has been adapted from the Pre-Design Field Sampling Plan.

## 3.2 GROUNDWATER MONITORING PROGRAM

### 3.2.1 O&M Monitoring Well Locations

The six groundwater monitoring wells and seven drinking water wells included in the quarterly O&M monitoring program are shown in Figure 3. The seventeen (MW09DB (SB) and MW15SB yet to be installed) groundwater monitoring wells included in the annual O&M monitoring program are shown in Figure 4. Additionally, the seventeen groundwater monitoring wells included in the 5 year review monitoring program are shown in Figure 5.

### 3.2.2 Monitoring Well Installation

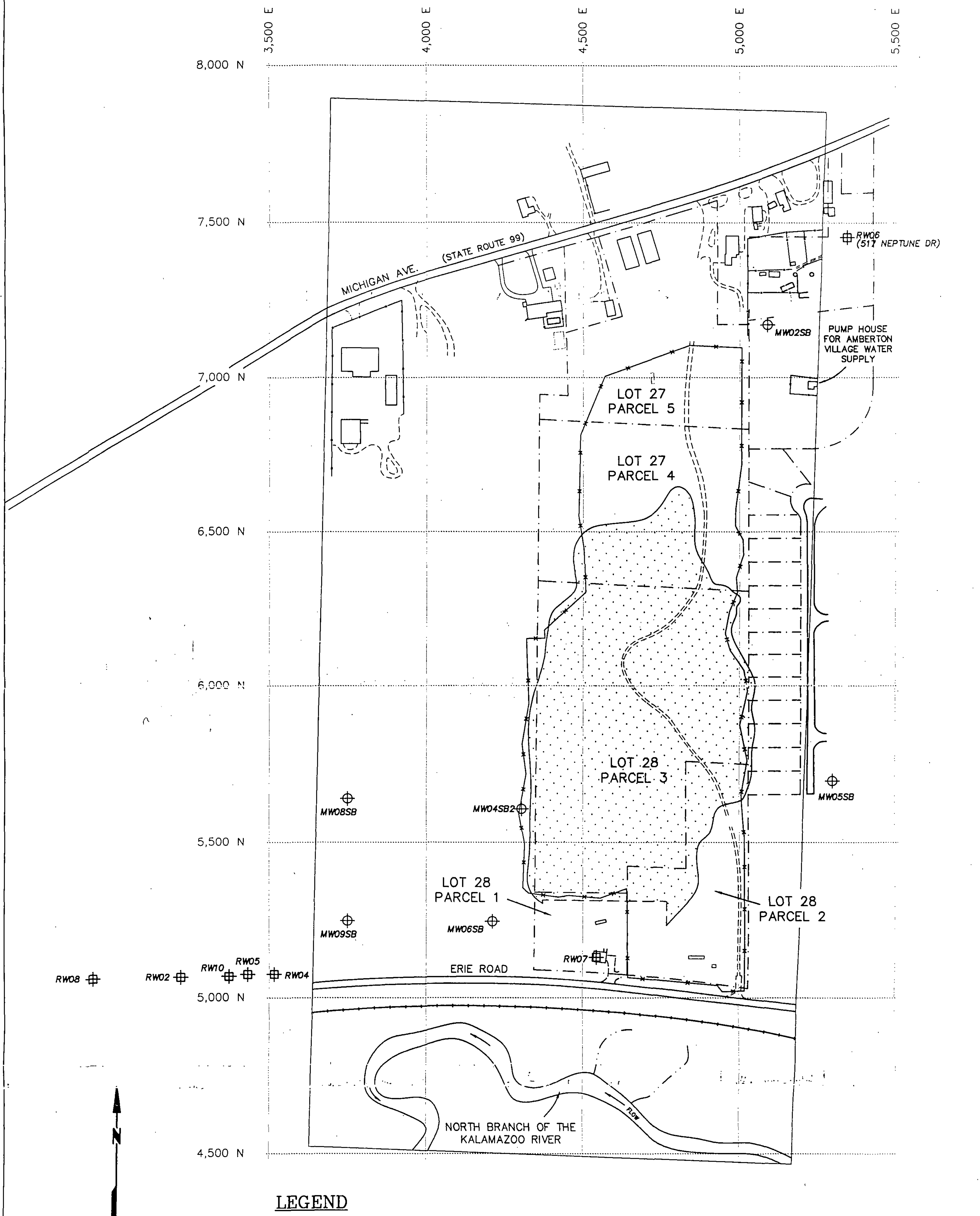
The two groundwater monitoring wells (MW09DB and MW15SB) will be constructed and developed in accordance with industry standards and the attached Standard Operating Procedures (SOP) 1 and 2. Riser pipe and well screen materials will be 2-in. diameter, schedule 80, polyvinyl chloride. The monitoring wells will be fitted with 5-ft-length of screens with #10 factory cut slot screens. MW15SB will be vertically sampled as detailed in SOP-01. Monitoring installation is expected to occur after an agreement/easement with the current landowner (Mr. Dick Gill) has been reached and in conjunction with abandonment of existing monitoring wells LF01, LF02, LF03, MW-West, MW-South and MW-East.

Following well installation, the wells will be tied into the existing survey. In addition, all monitoring and residential well locations that are included in the quarterly or annual sampling will be coordinated with a Global Positioning System.

### 3.2.3 O&M Groundwater Sampling Program

Water level measuring and groundwater sampling procedures will be consistent with the SOW and other relevant requirements of Part 115 of the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451 (Act 451 Part 115), formerly known as the Michigan Solid Waste Management Act or Act 641. A detailed description of these procedures is presented in the Standard Operating Procedures (SOPs) contained in Attachment A which are similar to the procedures detailed in the RD Work Plan FSP (WCC, June, 1996). However, a dedicated low flow (less than liter/min) bladder pump will be installed at each monitoring well for groundwater sampling. Water in the screened interval of lower aquifer wells will be isolated from water in the casing by use of an inflatable packer to avoid having to purge the entire water column. The sampling will utilize Micropurge techniques to minimize turbidity and mixing of the stagnant water in the well casing with water in the water screen collected for the analyses. Well installation, development, sampling and field analyses procedures are presented in SOP-3 through SOP-8.

The O&M monitoring and drinking water well quarterly and annual sampling/analysis events, summarized in Table 1, will commence following EPA and MDEQ approval of the Final Construction Report. A more detailed O&M groundwater monitoring schedule will be provided at least 30 days prior to initiation of the first quarterly event.




LEGEND

- APPROXIMATE LANDFILL BOUNDARY (DASHED PORTIONS INDICATE THE SURVEY GRID BOUNDARY)
- PROPERTY BOUNDARY
- UNPAVED ROAD
- INTERMITTENT STREAM
- FENCE LINE
- RAILROAD TRACK
- MONITORING WELL LOCATION
- RESIDENTIAL WELL MONITORING LOCATION

0 100 300 600

SCALE IN FEET

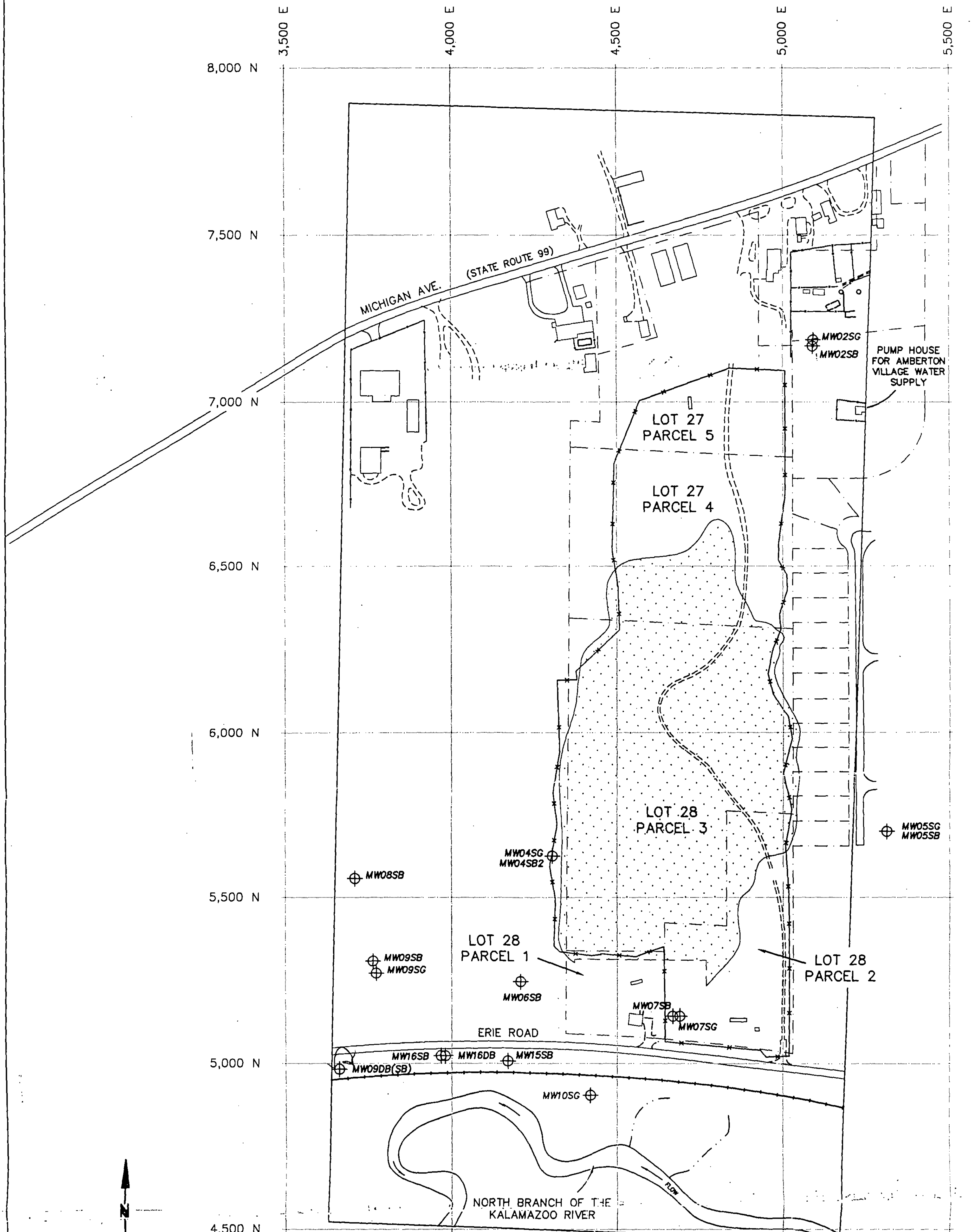
ALBION-SHERIDAN TOWNSHIP LANDFILL
ALBION, MICHIGAN

**Woodward-Clyde Consultants**
ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS

QUARTERLY O & M GROUNDWATER AND DRINKING WATER WELL MONITORING LOCATION MAP

| | | | |
|---|---|---|---|
| DRN BY: SWH | DATE: APR. 1997 | PROJECT NO. 6E07013 | FIG. NO. 3 |
| CHK'D BY: DS | DATE: APR. 1997 | | |

7013-03




## LEGEND

- APPROXIMATE LANDFILL BOUNDARY (DASHED PORTIONS INDICATE THE SURVEY GRID BOUNDARY)
- UNPAVED ROAD
- INTERMITTENT STREAM
- FENCE LINE
- RAILROAD TRACK
- MONITORING WELL LOCATION
- PROPERTY BOUNDARY

0 100 300 600

SCALE IN FEET

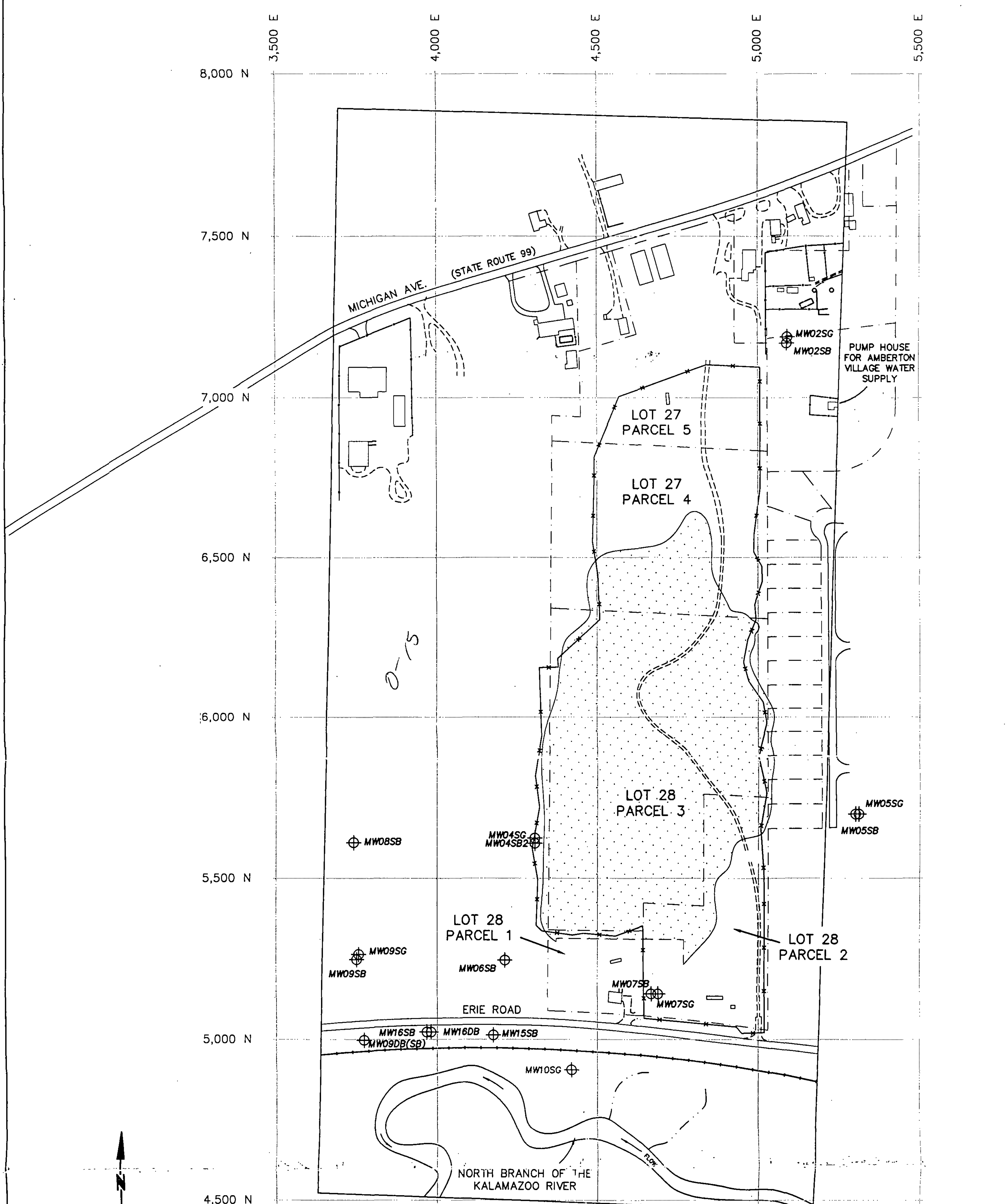
ALBION–SHERIDAN TOWNSHIP LANDFILL
ALBION, MICHIGAN

**Woodward-Clyde Consultants**
ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS

ANNUAL O & M
MONITORING WELL
LOCATION MAP

| | | | |
|---|---|---|---|
| DRN BY: SWH | DATE: APR. 1997 | PROJECT NO. 6E07013 | FIG. NO. 4 |
| CHK'D BY: DS | DATE: APR. 1997 | | |

7013–04




## LEGEND

- APPROXIMATE LANDFILL BOUNDARY (DASHED PORTIONS INDICATE THE SURVEY GRID BOUNDARY)
- PROPERTY BOUNDARY
- UNPAVED ROAD
- INTERMITTENT STREAM
- FENCE LINE
- RAILROAD TRACK
- MONITORING WELL LOCATION

0 100 300 600

SCALE IN FEET

ALBION–SHERIDAN TOWNSHIP LANDFILL
ALBION, MICHIGAN

**Woodward-Clyde Consultants**
ENGINEERS, GEOLOGISTS, AND ENVIRONMENTAL SCIENTISTS

FIVE YEAR REVIEW
MONITORING WELL
LOCATION MAP

| DRN BY: SWH | DATE: APR. 1997 | PROJECT NO. | FIG. NO. |
|---|---|---|---|
| CHK'D BY: DS | DATE: APR. 1997 | 6E07013 | 5 |

7013–05

### 3.2.4 O&M Groundwater Analysis Program

Table 1 summarizes the O&M Groundwater Analysis Program. The Remedial Action Quality Assurance Project Plan provides additional detail.

#### *Quarterly Groundwater Monitoring*

The quarterly groundwater monitoring program will consist of: 1) field parameters, 2) arsenic, and 3) ammonia. Field parameters include: groundwater depth/elevation before purging (except for drinking water wells); temperature; pH; specific conductivity; Eh; and dissolved oxygen.

The quarterly monitoring of the seven drinking water wells will consist of: 1) field parameters, 2) Special Analytical Services (SAS) low level organics, 3) SAS low level metals, cyanide (total), mercury, and 4) SAS parameters: chloride, sulfate, nitrate/nitrite, and ammonia.

#### *Annual Groundwater Monitoring*

The annual monitoring will be done in accordance with the SOW and consist of: 1) field parameters, and 2) chemicals of concern. Chemicals of concern will be 5 Target Analyte List (TAL) chemicals (Aluminum; Arsenic; Cobalt; Manganese; and Nickel), and 2 Target Compound List (TCL) volatile organic compounds (VOCs - Benzene and Vinyl Chloride), and antimony, ammonia and 1,2-Dibromo-3-chloropropane.

#### *Five-Year Review Groundwater Monitoring*

Designated monitoring wells will be sampled and analyzed for TCL organics, TAL inorganics and 1,2-dibromo-3-chloropropane to assist the EPA in meeting the requirements of Section 121(c) of CERCLA for the first five year review of the site. Five-year review groundwater monitoring will occur approximately 50 to 52 months after approval of the Final Design.

After the groundwater analytical data from the initial year of groundwater sampling has been evaluated, analytes will be removed from the list if the provisions of the generic residential cleanup criteria for the health based drinking water value for Public Act 307 amended, June 1995 Act 451 are met with the approval from the EPA and MDEQ. This list will be reevaluated each year upon the review of the full TCL and TAL laboratory results. A new compound may be added to the list for quarterly sampling parameters if it appears that the compound is originating from the landfill. A compound maybe dropped from the list if is not observed during the next consecutive quarterly sampling events above the appropriate residential or industrial cleanup criteria.

### 3.2.5 Chain of Custody Procedures

Chain of Custody procedures are described in SOP-03 in Attachment A.

### 3.2.6 Analytical Methods

Laboratory analysis of the groundwater samples and method detection limits will be in accordance with guidance published by the MDNR in Michigan Environmental Response Act (MERA) Operational Memorandum #6, Revision #4 dated September 13, 1995. Analysis and

**TABLE 1**
**SUMMARY OF THE O&M SAMPLING AND ANALYSIS PROGRAM**
**ALBION-SHERIDAN TOWNSHIP LANDFILL**



| Matrix | Field Parameters | Laboratory Parameters[1] | Analytical Method | Total Investigative Samples | Total Field Duplicates[2] | Total Trip Blanks | Total MS/MSD[4] | Total Samples |
|---|---|---|---|---|---|---|---|---|
| Groundwater (Quarterly) Monitoring Wells | Groundwater depth/elevation pH, Specific Conductance, Temperature, Dissolved $0_2$, Redox Potential | arsenic | SW-846-7060A | 6 | 1 | *NA* | -- | 7 |
| | | ammonia | EPA 350.3 | 6 | 1 | *NA* | -- | 7 |
| Groundwater (Quarterly) Drinking Water Wells | pH, Specific Conductance, Temperature, Dissolved $0_2$, Redox Potential | TCL-VOCs + 1,2-dibromo-3-chloropropane | SW-846-8260 | 7 | 1 | *(3)* | 1/1 | 10 |
| | | TCL-BNAs | SW-846-8270 | 7 | 1 | *NA* | 1/1 | 10 |
| | | TCL-Pest/PCBs | SW-846-8080 | 7 | 1 | *NA* | 1/1 | 10 |
| | | TAL Metals | | | | | | |
| | | mercury | SW-846-7471A | 7 | 1 | *NA* | 1/1 | 10 |
| | | cyanide | SW-846-9012 | 7 | 1 | *NA* | 1/1 | 10 |
| | | chloride | EPA 325.2 | 7 | 1 | *NA* | 1/1 | 10 |
| | | sulfate | EPA 374.4 | 7 | 1 | *NA* | 1/1 | 10 |
| | | nitrate/nitrite | EPA 353.2 | 7 | 1 | *NA* | 1/1 | 10 |
| | | ammonia | EPA 350.3 | 7 | 1 | *NA* | 1/1 | 10 |
| Groundwater (Annual) Monitoring Wells | Groundwater depth/elevation pH, Specific Conductance, Temperature, Dissolved $0_2$, Redox Potential | arsenic, aluminum, antimony, cobalt, manganese,nickel | SW-846-6010/ 7000 series | 17 | 2 | *NA* | 1/1 | 21 |
| | | benzene, vinyl chloride, 1,2-dichloro-3-chloropropane | SW-846-8260 | 17 | 2 | *(3)* | 1/1 | 21 |
| | | ammonia | EPA 350.3 | 17 | 2 | *NA* | 1/1 | 21 |

## TABLE 1
## SUMMARY OF THE O&M SAMPLING AND ANALYSIS PROGRAM
## ALBION-SHERIDAN TOWNSHIP LANDFILL



| Matrix | Field Parameters | Laboratory Parameters[1] | Analytical Method | Total Investigative Samples | Total Field Duplicates[2] | Total Trip Blanks | Total MS/MSD[4] | Total Samples |
|---|---|---|---|---|---|---|---|---|
| Groundwater (Five Year Review) Monitoring Wells | Groundwater depth/elevation pH, Specific Conductance, Temperature, Dissolved $0_2$, Redox Potential | TCL-VOCs + 1,2-dibromo-3-chloropropane | SW-846-8260 | 17 | 2 | *(3)* | 1/1 | 21 |
| | | TCL-BNAs | SW-846-8270 | 17 | 2 | *NA* | 1/1 | 21 |
| | | TCL - Pest/PCBs/ | SW-846-8080 | 17 | 2 | *NA* | 1/1 | 21 |
| | | TAL Metals | SW-846-6010/ 7000 series | 17 | 2 | *NA* | 1/1 | 21 |
| | | cyanide | SW-846-9012 | 17 | 2 | *NA* | 1/1 | 21 |
| Landfill Gas Migration Monitoring Probes (Quarterly) | $CH_3$ $O_2$ $H_2S$ % LEL | NA | NA | 4 | N/A | N/A | N/A | 4 |
| Landfill Gas Monitoring Event (one time event) | | Select VOCs[5] | TO-14 | 3 | 0 | 0 | 0 | 3 |

Notes:

(1) Refer to QAPP Tables 7-1 and 7-2 for complete description of analytical methods.

(2) Field duplicates will be collected at a rate of one per 10 investigative samples.

(3) One trip blank set will be included with each shipping cooler containing samples for VOC analysis.

(4) Matrix spike/matrix spike duplicate sample for organics, matrix spike/laboratory duplicate for inorganics. These QC samples will be collected at a rate of one per 20 investigative samples. Triple the normal volume is required for VOCs and double sample volume is required for all other parameters.

(5) Select VOCs include: 1,2 dichloroethane, benzene, tetrachloroethylene, chloroform, methylene chloride, vinyl chloride, 1,1 dichloroethylene, trichloroethylene, carbon tetrachloride

NA - Not applicable

TCL - Target Compound List (Low Concentration)

TAL - Target Analyte List (Low Concentration) method detection limits are expected to be similar to those detailed in the Remedial Design Work Plan (WCC, June, 1996).

### 3.2.7 Quality Assurance and Quality Control

Quality assurance/quality control (QA/QC) procedures will be implemented to ensure the accuracy of the analytical data acquired during the monitoring program. The QA/QC procedures to be implemented in the field will be described in the O&M Quality Assurance Project Plans (QAPP) which will be similar to the RD QAPP (WCC, 1996).

### 3.2.8 Data Validation Procedures

Data validation procedures will be performed for both field and laboratory operations as described in the QAPP.

### 3.2.9 Requirements for Health and Safety Protocols

All contractors or subcontractors performing work at the site shall comply with the Health and Safety Plan, applicable local, state and federal laws and regulations and specific SOPs. Requirements for Health and Safety Protocols will be described in the Health and Safety Plan (HASP).

### 3.2.10 Schedule

The initial quarterly groundwater sampling and analysis event will occur after cap construction is completed following EPA approval of the Final Construction Report. Thereafter, groundwater sampling and analysis will be conducted on a quarterly basis for the first five years of the monitoring program.

The sampling schedule may be modified in the future with the approval of U.S. EPA and consultation with MDEQ.

### 3.2.11 Reporting

The quarterly field and laboratory data will be reported as required in Section 3 of the SOW within 30 days of receipt and data validation of analytical data. The quarterly report will include:

- A brief description of the monitoring system at the facility and a map showing the location of the monitoring points.
- A discussion of recent and long-term trends in the water quality and water level data.
- Tabulation of all analytical results to date. If the presence of a certain VOCs are determined to be false positives, the report will discuss the laboratory data interpretation and present the supporting quality assurance/quality control information.

- A summary table which identifies those parameters which have concentrations exceeding groundwater quality, or air emission risk calculation limits (for the first year).
- Suggestions for any additions, changes, to maintenance needed in the monitoring system.
- Groundwater contour maps and arsenic isoconcentrations maps.

Additional text, tables, figures, or graphs will be included (as appropriate) in the monitoring reports to aid in evaluating the landfill monitoring program.

Within 60 days of receipt and data validation of results from the annual event and annual summary report will be submitted to the U.S. EPA and MDEQ. The annual summary report will include the above as well as time/concentration plots of select parameters

## 3.3 LANDFILL GAS MONITORING PROGRAM

The Statement of Work (SOW) for the remedial action at the ASTL establishes the requirements for performance of the remedial action. One of these requirements is the following:

> *At all times during the performance of the remedial action, air emissions shall not exceed a total cancer risk of $1 \times 10^{-6}$ at the fenceline, using risk calculation methods set forth in Risk Assessment Guidance for Superfund. In addition, the air emissions shall not exceed any Applicable or Relevant and Appropriate Requirements (ARARs).*

During the Pre-Design Studies, WCC used the Landfill Air Emissions Estimation Model (U.S. EPA, 1991, Landfill Air Emissions Estimation Model, EPA-600/8-90-085a, April 1991 and *Air/Superfund National Technical Guidance Study Series, Models for Estimating Air Emission Rates from Superfund Remedial Actions* U.S. EPA. 1993) to predict the total landfill gas, the remaining potential gas reserves and the chemical-specific landfill gas generation rates and downwind concentrations of these chemicals. It was demonstrated that the total cancer risk level of $1 \times 10^{-6}$ will not be exceeded at the fenceline from/during RA activities or waste consolidation activities and that the SOW requirements will be met by a passive gas venting system without any controls on gas emissions. It should be noted that the Landfill Air Emissions Model predicted a decreasing trend in the gas production rate starting approximately 2 years after landfill closure (1981).

### 3.3.1 Objectives

The objective of the landfill gas performance monitoring is to verify the total gas generation rate and evaluate the concentration of specific toxic pollutants that are regulated under Michigan Public Act 348 and to detect the lateral migration of gas through the subsurface.

### 3.3.2 Monitoring Locations

#### *Gas Vent Monitoring*

At the completion of construction, field sampling of the landfill gas will be completed to verify the total gas generation rate and determine the concentration of specific pollutants. Two gas vents, located in the areas of greatest waste thickness (Sheet 7), will be selected for specific VOC sampling and analysis. Attempts will be made to estimate the rate of gas emissions from the landfill by measuring flow rates from the vent pipes. One downwind fenceline location will also be analyzed to determine fenceline concentrations of specific VOCs. Meteorological data will be collected to allow consideration of atmospheric changes for three days in advance of the landfill gas measurements. Data will be recorded and used to establish a baseline of landfill gas constituents and flow rates for comparison to model estimates.

#### *Gas Probe Monitoring*

Five gas monitoring proves will be installed as indicated on Sheet 8 using normal well installation procedures (see SOP-01 and Sheet 8). Monitoring of the probes will be completed on a quarterly basis for methane and hydrogen sulfide.

### 3.3.3 Monitoring Frequency

The two gas vents and one downwind location will be monitored once following completion of the Prefinal Construction Inspection. If concentrations detected are below a total cancer risk of $1x10^{-6}$ as predicted by the model, then specific VOC gas monitoring activities will be discontinued.

Quarterly gas probe monitoring will be discontinued and the probes will be properly abandoned if the levels of explosive gases remain below 10% of the Lower Explosive Limit (LEL) for 8 quarters.

### 3.3.4 Field Procedures

Field procedures for sampling landfill gas are detailed in SOP-09 and SOP-10 in Attachment A of the Operation and Maintenance Plan.

### 3.3.5 Laboratory Analyses

Gas samples from the two gas vents and the fenceline monitoring event will be analyzed for the following analytes:

- 1,2 Dichloroethane
- Benzene
- Tetrachloroethylene
- Chloroform

- Methylene Chloride
- Vinyl Chloride
- 1,1 Dichloroethylene
- Trichloroethylene
- Carbon Tetrachloride

### 3.3.6 Reporting

Landfill gas collection system construction and gas monitoring probe installation diagrams will be reported in the completion of the Remedial Action Report.

The field and laboratory data will be reported to the U.S. EPA and MDEQ in the quarterly or annual report after completing data validation.

## 3.4 REPORTING AND RECORDKEEPING

### 3.4.1 Site Inspection Logs

A site specific O&M inspection report addressing the operations and maintenance activities will be established and maintained throughout the project. This record will include the following as a minimum:

- Identity of project and inspector
- Date and time of inspection
- Weather conditions
- Observations
- Actions, if any
- Recommendations for improvement
- Reference to actions report, if separate
- Distribution list
- Signatures

Site specific report forms will be established and will include the information outlined above. Additional information concerning inspections is included in Section 4.0 of this O&M Plan.

### 3.4.2 Laboratory Records

Laboratory records obtained from monitoring activities of groundwater and landfill gas will be filed for subsequent reporting to the agencies. Originals of sampling, analyses and chain-of-custody procedure will be placed in the project file for future considerations. Laboratory records will include date and time of sampling, chain-of-custody and analyses, signature of person(s) performed the analyses and sample collection method. Analysis method type and number shall also be recorded. The Quality Assurance Project Plan (QAPP) further details requirements for laboratory reports.

### 3.4.3 Records for Operation and Maintenance Costs

The O&M Manager shall keep a record of all costs incurred from implementing activities related to monitoring and maintenance of the landfill cover. The O&M Manager shall submit an adequate tabulated estimate for the annual post-closure care expenses that will identify the O&M item name description (size or amount) and annual cost report to be submitted with the cost analyses table to the agency each year. The O&M items will include, but are not limited to, the following:

- Revegetation of cover (area/year, unit costs);
- Repair of routine erosion damage of cover, berms and drainage features (area/year, topsoil unit costs);
- Security system maintenance and repair (fence length/year, unit costs);
- Staff costs (cost/year);
- Groundwater level monitoring, sampling, and well inspection/maintenance;
- Gas system monitoring, sampling and maintenance;
- Groundwater quality analysis (sample/year, unit cost);
- Air/gas analysis;
- Monitoring device replacement (item/unit cost); and
- Annual reporting.

The O&M Manager shall submit a cost estimate for contingency expenses. A separate report and cost analyses table shall be provided to The Group if contingency expenses occur. The identified system failures that require contingency planning are listed in Section 3.3.2.

### 3.4.4 Personnel and Maintenance Records

Records pertaining to all personnel involved in the O&M field activities will be kept in the project files. Site personnel will be 40-hour OSHA trained and have the 8-hour refresher training as required by OSHA standards. Medical surveillance of personnel will be maintained in accordance with OSHA standards 20 CFR 1910.120 (f).

Maintenance activities will be recorded on pre-developed maintenance forms. These forms will include date, type, description of executed maintenance work, name of person performing the activity, and a section to include planned preventive maintenance for the next reporting period. Equipment maintenance, instrument calibration, and PPE decontamination will also be documented. If requested by U.S. EPA or the State of Michigan, maintenance records will be supplied to the agencies for any reporting event after being reviewed and approved by the O&M Manager.

### 3.4.5 Reporting Emergencies

In case of an emergency associated with the post-closure care, the O&M Manager will report the incident on a site-specific Emergency Report within 14 days of the incident. Emergency medical care will be recorded and signed by the assigned medical facility. Reports will include a detailed description of the incident, and in case of a chemical release, the report will include the measures that were undertaken to mitigate the situation. More details pertaining to handling emergencies, will be included in the Emergency and Contingency plans included with the site-specific Health and Safety Plan (HASP).

### 3.4.6 Reporting

The Group's reporting frequency to U.S. EPA and MDEQ during the post-closure case period for items other than those discussed specifically in the supporting documents will be the following:

- First Year - semi-annually
- Each Subsequent Year - annually

The report form and instructions are subject to approval; it will describe current post-closure conditions of the landfill cap and will include at least the following:

- Facility name and address, quarter or year covered by the report, and the signature of the O&M Manager to certify the accuracy of the report
- Maintenance activities
- An update on post-closure and contingency action cost estimate (annual report)
- A summary and discussion of inspection records and results performed by the O&M Contractor
- A submittal of all site-specific emergency reports
- Monitoring, testing, and analytical data results
- Summary of all events requiring the use of the contingency plan
- Any corrective actions taken or required for the monitoring, security system or remedial action
- Upon request, copies of monthly and storm event inspection reports, strip charts, log books, laboratory/monitoring data, and other O&M related data

The monitoring part of the report shall contain, at least, the following items:

- A brief description of the monitoring system at the facility and a map showing the location of the monitoring points.
- A discussion of recent and long-term trends in the water quality and water level data.
- Tabulation of all analytical results to date. If the presence of a certain constituents are determined to be false positives, the report will discuss the laboratory data interpretation and present the supporting quality assurance/quality control information.

- A summary table which identifies those parameters which have concentrations exceeding groundwater quality, or air emission risk calculation limits (for the first year).
- Suggestions for any additions, changes, to maintenance needed in the monitoring system.

Additional text, tables, figures, or graphs will be included (as appropriate) in the monitoring reports to aid in evaluating the landfill monitoring program.

## 3.5 SAFETY PLAN

A detailed description at the requirements of the site HASP is provided in the model HASP included as Appendix B of the Remedial Action Work Plan. The O&M Contractor will be required to submit a site-specific HASP.

### 3.5.1 Safety for Site Personnel

Proper health and safety precautions will be taken while performing site inspection, monitoring and scheduled or emergency maintenance.

The O&M Manager shall maintain the safety equipment in accordance with the requirements of the Site Health and Safety Plan.

### 3.5.2 Safety in Case of System Failure

Details on required safety precautions and pathways to be followed during system failure will be presented in the appropriate sections of the HASP.

The following are potential system failures that require maintenance or could require emergency and contingency planning actions:

- Failure of liner
- Failure of monitoring systems requiring replacement or repair
- Vandalism of security system or landfill cover
- Excessive erosion
- Excessive cover settlement
- Excessive/unacceptable gas generation and migration

## 4.1 GENERAL SITE MAINTENANCE

The Site will have a maintenance program that meets the requirements of the UAO, safety requirements, environmental regulations, project specifications and Drawings. During the maintenance practices described in this plan, the O&M Manager will maintain compliance with the requirements for health and safety protocols presented in the O&M Contractor's HASP. The Site will be inspected by the O&M Manager and maintained, as necessary, by the O&M Contractor.

For site inspections or sampling activities, the O&M Manager will maintain access throughout the Site. General site maintenance may require the O&M Contractor to collect debris or waste resulting from maintenance and repairs. Only approved containers that are accepted by disposal facilities and meet DOT regulations for containment and shipping (such as a roll-off box) will be used for the collection and disposal of debris or waste. Type II Landfills will be the only disposal option for waste; any other disposal option will be discussed with U.S. EPA.

All safety equipment will be provided by the O&M Manager as required for site inspections or sampling events. The O&M Contractor will provide necessary safety equipment of repairs to the cover and other site features.

### 4.1.1 Site Entrance, Fence, and Access Road

Maintenance of the entrance/exit to the Site will include measures to stabilize the area and to control the tracking of materials from the Site during repair/maintenance activities. The Site entrance area will comply with the following requirements:

- Provide parking for vehicles in a designated area. Parking will be maintained in such a way to control rutting, flooding and dust.
- The entrance/exit road will be maintained in such a way to control rutting, flooding and dust.
- The gates and locks will be kept in good working order.

The O&M Manager will inspect the entrance/exit on a quarterly basis. As appropriate, gravel will be applied in areas where repairs are necessary. The O&M Manager will maintain road and footpath access to avoid excessive damage (e.g., rutting) and to provide access to the work areas for monitoring and inspection.

The Site chain link fence and warning signs will be inspected on a quarterly basis by the O&M Manager for the first year and then annually thereafter. The perimeter chain-link fence and entrance gates will be inspected for settlement or damage. Paper and other trash collected on the fence (e.g., due to wind) shall be removed. If required, any damage shall be immediately reported to the O&M Manager, repaired and recorded in the project files.

### 4.1.2 Stormwater Control and Erosion Protection

Stormwater runoff will be collected by the berms and perimeter drainage features along the side slopes and be discharged to the infiltration basin(s). The details for the permanent controls are available in the project specification and design drawings. These documents will be available to the O&M Inspector prior to the start of the post-closure period, and are incorporated into this O&M Plan by reference.

If cover, berm or drainage feature repairs are necessary, the Contractor will prepare and submit to the O&M Manager, prior to construction of controls, a storm water control/erosion protection plan. The plan will outline the Contractor's proposed methods for controlling storm water runoff and soil erosion control practices to be used during the repairs. Controls to be used may include temporary soil berms, sediment trap(s), silt fences, hay bales seeding, mulching and/or other erosion control devices.

### *Stormwater Control Inspection Requirements*

A description of the permanent storm water controls consist of the following:

- Landfill cap slopes
- Berms
- Drainage features

The O&M Inspector shall regularly inspect all controls at the Site. Specific observations for each control will include:

Infiltration Basin(s)

- Presence and depth of sediment in the basin
- Conditions of side slopes

Berms and swales

- Erosion
- Collection of sediments

Slopes

- Erosion

### *Stormwater Control Inspection Schedule*

All controls shall be maintained in a safe and working condition to accomplish their designed purpose. Observed damage to the structures will be repaired as quickly as possible. All controls will be inspected by the O&M Inspector on the following schedule:

- At least once quarterly for the first year and semi-annually thereafter (fall and spring)
- Within 24 hours of a storm of 1-inch of rain fall (or greater) throughout the post-closure period.

### *Stormwater Control Practices*

Erosion of slopes and infiltration basins will be redressed, areas of serious erosion may require additional actions (i.e., riprap armoring/diversion controls).

### 4.1.3 Monitoring Wells and Gas Vents

Monitoring wells and gas vents shall be inspected and maintained, if necessary. The focus of inspections are to immediately identify and respond to system conditions that have caused or may soon cause the system to malfunction. The inspections include a visual evaluation of monitoring wells and gas vents.

The systems are designed such that routine inspections can be handled quickly and with minimal effort by inspection personnel. Details on gas vents can be found in the design drawings. Monitoring well boring logs have been previously submitted (WWES, 1994 and WCC, 1996).

Pre-developed inspection log sheets shall be completed for each record inspection event. A duplicate set of inspection and maintenance files shall be supplied to the agencies if requested. The frequency of inspection is indicated below for each monitoring system.

#### *Monitoring Wells*

The following routine inspection and maintenance points shall be observed and reported after each monitoring event:

- Verify that well head box covers are locked;
- Verify that sediment or organic growth is not developing in the well head box;
- Consult with the O&M Manager about the required maintenance.

#### *Gas Collection/Venting System*

The following routine inspection and maintenance points shall be observed and reported semi-annually:

- Vents for damage, clogging or other obstructions to gas flow.
- Repair any mechanical damage to vents, or perform maintenance required to remove any obstructions.

### 4.1.4 Dust Control

If repairs/maintenance are required that could cause dusting, such as cover repair, the release of dust from the Site will be controlled by water spray at the entrance and access roads. Dust generation is expected during periods of dry weather conditions.

## 4.2 CAP PERFORMANCE

The remedial action is capping of the landfill. This remedial action is considered to be protective of human health and the environment because it reduces the risks associated with exposure to contaminated materials and reduces the potential for migration of contaminants to groundwater.

### 4.2.1 Potential Performance Problems

The following factors will affect cap integrity and performance:

1) Deterioration of Vegetative Cover

The deterioration of vegetation may occur due to:

- Poor maintenance
- Foul weather conditions
- Improper fertilization
- Poor quality cover soil
- Landfill gas
- Insect damage

2) Surface Disturbance

Surface disturbance may be due to the following:

- Unwarranted vehicle traffic
- Animal burrowing
- Freeze and thaw
- Cyclic wetting and drying

3) Other Deficiencies

Excessive settlement caused by the underlying waste or foundation soil can rupture the cap system. Down-slope slippage or creep due to failure in the liner should be inspected. If any of these failures are detected during an inspection, the original design calculations will be reviewed.

4) Excessive Erosion

Excessive erosion may be caused by the following:

- Surface water run-off
- Wind

5) Disruption of Original Grade

Disruption of original grade may be due to any or all of the above factors.

### 4.2.2 Problem Remedies

Problems identified during cap inspections will be rectified after evaluating the type and location of damage observed on the landfill cover and/or associated systems. The appropriate course of action to repair damage to the cap should be determined by the O&M Manager. The course of action that was taken to repair the damage to the cap will be described in the annual report which is provided to the agency. This report will contain the schedule used for implementing the repairs.

## 4.3 LANDFILL CAP MAINTENANCE PLAN

The landfill cap maintenance plan consists of regular inspections, grass cutting, repairs and drainage layer exits and drainage lines, cap slopes and ditches. The following is a description for each of these components.

### 4.3.1 Regular Inspection

A regular inspection of the cap consists of evaluating the cap integrity at least twice a year (fall and spring) and after storm events. This inspection will include observations concerning the following:

- Erosion of cap
- Rain water
- Condition of vegetation
- Animal burrows
- Cap settlement
- Condition of drainage layer exits

### 4.3.2 Maintenance

Maintenance of the cap will consider the following:

1) Grass
    - Establish a schedule for cutting grass; it is expected that cutting will be performed after the grass has seeded
    - Repair damaged grass areas and stressed vegetation when the aerial extent exceeds 200 square feet
    - Remove detrimental volunteer growth, such as bushes or saplings
2) Cap Settlement
    - Changes in the final topography that causes ponding of rainwater of the cap will be reported to the O&M Manager.

3) Drainage Layer Exits and Drainage Lines

- Erosion of gravel blankets,
- Rutting,
- Excessive and detrimental volunteer grass growth.

4) Cap Slopes

- Erosion - regrade and reseed when damage caused by erosion exceeds 8 inches in depth,
- Vegetation - stressed vegetation and bare areas shall be repaired as appropriate,
- Settlement/Subsidence.

5) FML

- Repairs will be reported to the U.S. EPA within thirty (30) days of identifying that repairs are needed.
- Repair or replacement of the liner system elements will be made within sixty (60) days, weather permitting.

### 4.3.3 Repairs

All repairs shall be in accordance with the specifications for the damaged elements of the cap and will be verified by the O&M Inspector and reported to the agencies by the O&M Manager. The O&M Manager will consult with The Group, and if needed, the Engineer, prior to initiating repairs.

## 5.1 TYPE OF EQUIPMENT

Equipment types used during the O&M activities fall in the following categories:

- Monitoring equipment
- Safety and emergency equipment
- Security devices
- Stormwater management system

Equipment used for water level measurement, groundwater sampling, well development, landfill gas monitoring are listed and discussed in the PMP.

## 5.2 INSTALLATION OF MONITORING EQUIPMENT

Monitoring well material and installation procedures are presented in Section 3.

## 5.3 SITE EQUIPMENT MAINTENANCE

Site monitoring and structural equipment are discussed in Section 4.0.

## 5.4 FIELD EQUIPMENT CALIBRATION AND MAINTENANCE

Instruments used to perform field measurements and readings shall be calibrated according to manufacture's procedure and frequency. Information on instrument maintenance and calibration is presented in Attachment A.

## 5.5 REPLACEMENT OF EQUIPMENT

The replacement of monitoring or structural equipment that is identified in Section 5.1 will require the approval of the O&M Manager. Field testing and inspection equipment shall be replaced whenever they are no longer capable of functioning within the manufacturer's specifications.

The Project Management Team that will be used is presented in Figure 6.

U.S. EPA: Remedial Project Manager Responsible for the O&M oversight activities for the remedial action performance.

Name:

Address:

Telephone:

The Group: Responsible for coordinating the O&M of cap between the agencies, O&M Manager and the O&M Contractor.

Name:

Address:

Telephone:

O&M Manager: Responsible for implementing the O&M Plan according to the content of this manual, reports to the Group, and responds to an emergency or contingency case. The O&M Manager directs the O&M Inspector and O&M Contractor.

Name:

Address:

Telephone:

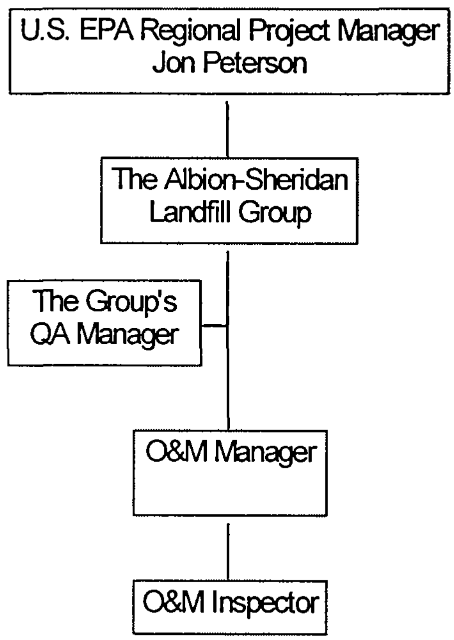
O&M Inspector: Responsible for the on-site O&M inspections, assigned by the O&M Manager.

Name:

Address:

Telephone:

FIGURE 6
PROJECT ORGANIZATION TEAM
ALBION-SHERIDAN TOWNSHIP LANDFILL
OPERATION AND MAINTENANCE



W.W. Engineering & Science, April 1994, Final Remedial Investigation Report of the Albion-Sheridan Township Landfill, Albion, Michigan, U.S. EPA Contract No. 68-W8-0079.

U.S. EPA (1988) Community Relations in Superfund - A Handbook, EPA/540/G-88/002, OSWER Directive 9230.0-3B.

U.S. EPA (1986) Superfund Remedial Design and Remedial Action Guidance, OSWER 9355.04A.

U.S. EPA Region V (1995) Statement of Work for Remedial Design and Remedial Action at Albion-Sheridan Township Landfill Site, Calhoun County, Michigan.

U.S. EPA Region V (1995) Declaration for the Record of Decision, Albion-Sheridan Township Landfill Site, Albion, Michigan.

U.S. EPA Region V (1995) Unilateral Administrative Order For Remedial Design and Remedial Action, Albion-Sheridan Township Landfill, City of Albion, Corning Glass, Inc., Decker Manufacturing, Inc., and Cooper Industries, Inc., Respondents.

Woodward-Clyde Consultants (1996) Pre-Design Studies Report Albion-Sheridan Township Landfill, Calhoun County, MI.

Woodward-Clyde Consultants (1997) Preliminary (30%) Design Albion-Sheridan Township Landfill, Calhoun County, MI.

ATTACHMENTS

A

**ATTACHMENT A**

[redacted] STANDARD OPERATING PROCEDURES
PERFORMANCE MONITORING PLAN
ALBION-SHERIDAN TOWNSHIP LANDFILL
ALBION, MICHIGAN

Prepared for
The Albion-Sheridan Landfill Group
Albion-Sheridan Township Landfill Site

August 1997

Woodward-Clyde Consultants
38777 West Six Mile Road, Suite 200
Livonia, Michigan, 48152

Project Number 6E13045

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**SOP-01**

**MONITORING WELL INSTALLATION IN BEDROCK AQUIFER**

## 1.0 OBJECTIVE

This document describes the standard procedure to install and develop a monitoring well or piezometer in the lower (bedrock) aquifer in a landfill environment. SOP-8 describes the decontamination procedures which are applicable to this SOP.

## 2.0 EQUIPMENT

The following is a list of equipment and well materials for the well installations:

- Drill rig with 6-in tricone bit.
- Temporary casing (4" steel).
- High pressure steamer/sprayer.
- Weighted tape measure.
- Water level probe.
- Drums for containment of cuttings.
- Health and safety equipment (see HASP).
- Field book.
- Location map.
- Boring log form.

## 3.0 DRILLING PROCEDURE

All drilling equipment, including the drill rig, water tanks, and all downhole equipment will be decontaminated according to SOP-8. Downhole equipment will be decontaminated between boreholes, and other equipment such as the drill rig will be decontaminated between different work areas. Drilling fluid water will be obtained from the local public water supply system. The water supply was previously sampled for contaminates of concern (TCL Organics, TAL

Inorganics and 1,2-Dibromo-3-Chloropropane) during Pre-Design Studies to ensure cross contamination does not occur from this source and it is not anticipated that this will be required again.

1. Identify the areas having buried structures and utility lines with the appropriate local authorities.

2. Advance the borehole and temporary casing (to bedrock) from the ground surface to the required depth using hollow stem auger (HSA) and rotary methods with water as the drilling fluid and log the cuttings. The diameter (O.D.) of the tricone bit will be approximately 6 inches and the diameter of the HSA (I.D.) will be approximately 4 1/4 inches.

3. If required (only in MW15SB), install temporary well with packer, develop and collect sample, repeat as necessary (see Section 3.1).

4. Conduct 5 foot interval NX Coring to verify that competent bedrock is present.

5. Install monitoring well/remove temporary casing (see 5.0).

### 3.1 Vertical Aquifer Sampling

Vertical aquifer sampling (VAS) in MW15SB will be accomplished using the temporary well method and will commence within the first 10 foot interval upon encountering the uppermost aquifer. When the boring and temporary casing have been advanced 10 feet into the uppermost aquifer, a temporary well casing and screen with a packer above the screen will be used to sample the lower 5 foot portion of the boring. The temporary well will be developed as described in SOP-02 and a groundwater sample will be collected. Field analysis of the sample will include the field parameters as described in Section 6.5 of the Performance Monitoring Plan (PMP).

This sequence will continue to the base of the weathered bedrock. Five foot interval NX Coring will be performed upon encountering bedrock to determine depth to competent bedrock.

The drilling/sampling sequence will stop upon encountering competent bedrock. Field results showing the greatest abnormality compared to results within the other sampling intervals will determine the final well screen placement. Previous work at the site has shown Eh and dissolved oxygen to be indicator parameters which correlate and/or influence the concentrations of arsenic in groundwater. Further, results of the RI (April, 1994) found that the results of VAS did not indicate a preferred sampling zone within the unweathered bedrock and all shallow bedrock wells were set approximately ten feet below the top of the unweathered bedrock.

Following determination of final screen placement depth, the monitoring well will be installed as described in Section 5.0.

## 4.0 MONITORING WELL MATERIALS

### 4.1 Surface Casing

Surface casing will consist of new, 6-inch diameter steel protective casings with a steel protective locking cap.

### 4.2 Cement -Bentonite Grout

A mixture of water/cement/bentonite at a 6 gallon/94 pounds/4.7 pounds (5% by weight of cement) ratio will be used to grout the annular space between the surface casing and the borehole. The annular space between the well casing and the borehole and surface casing will be grouted from the top of the bentonite seal to ground surface. The cement-bentonite grout will be mixed in a powered mechanical grout mixer according to the manufacturer's specifications.

### 4.3 Well Casings

Well casings will consist of new, threaded, flush-joint, 2-inch (ID) PVC. The well casing will extend from the top of the well screen to approximately 2 feet above ground surface. The tops of all well casings will be fitted with threaded caps that can be easily removed by hand.

### 4.4 Well Screens

The screens will consist of 5-foot long, new, flush-threaded joint PVC screen with a factory cut 0.010-inch slot. A threaded cap will be provided at the bottom of the screen.

### 4.5 Filter Pack

The filter pack material will be sand with a 16-40 size gradation. The filter pack will extend approximately 2 feet above the top of the screen, but in no case less than 6 inches above the screen. The final depth to the top of the filter pack will be measured by using a weighted tape measure.

### 4.6 Bentonite Seal

A bentonite seal will be installed above the filter pack. The seal will consist of a layer of commercially-available bentonite pellets.

## 5.0 MONITORING WELL INSTALLATION PROCEDURES

### 5.1 Monitoring Well Installation

Monitoring well installation will begin after formation water and fine grained sediment have been flushed by pumping drilling water through the rods.

The borehole depth will be measured to the nearest 0.1 foot. The casing and screen will be installed in the boring and cut off 2 ft above ground. The portion of the well casing cut off at the top will be measured and subtracted from the total length supplied to determine the total well assembly length.

Once the well assembly is in place, the filter pack will be added slowly to the zone below the water level in the borehole by tremie pipe as the temporary casing is removed. Depth measurements of the top of the filter material will be taken periodically in the well annulus as the filter pack is placed. The top of the filter pack will be measured by a weighted tape measure.

A minimum 2-foot thick bentonite pellet seal will be installed immediately above the filter pack. The bentonite pellets will be added slowly to reduce the chances for bridging of the pellets. The completed bentonite seal will be allowed to hydrate for approximately 30 minutes before proceeding with the grouting operation.

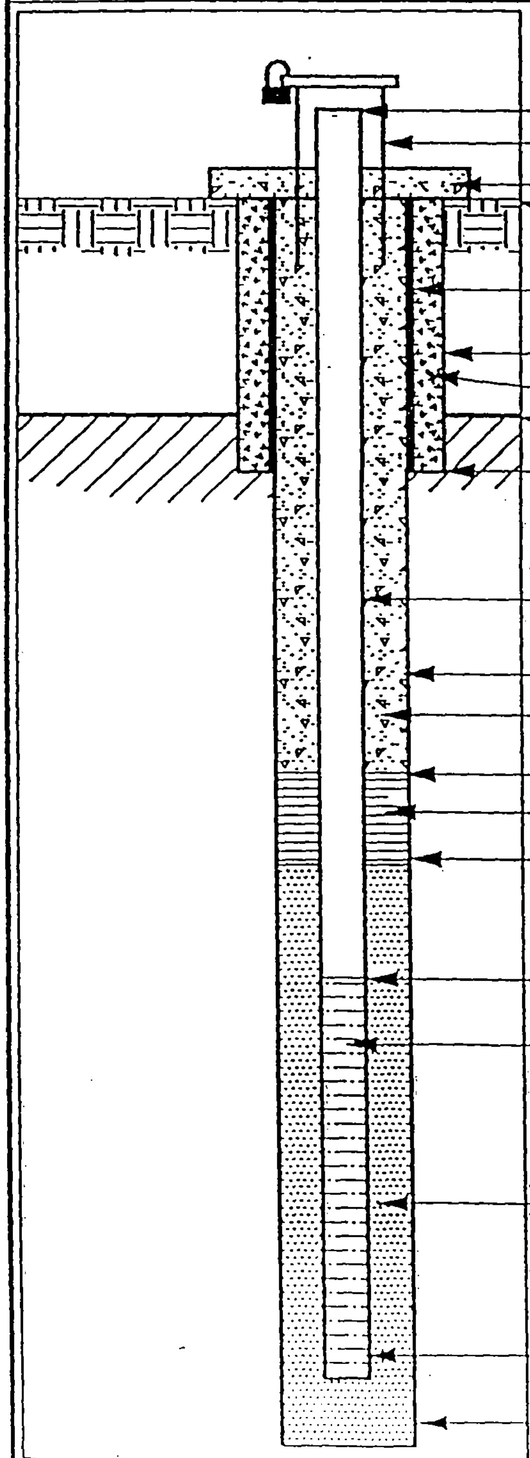
Cement-bentonite grout backfill will be placed from the top of the bentonite seal to 1 1/2 to 3 feet below ground surface. The grout will be tremied into the well annulus using a side-discharge tremie until it is completely full. After settlement of the bentonite grout has been allowed for 24 to 72 hours, the protective steel casing will be embedded in nonshrink concrete. The cement- will occupy the upper 1 1/2 to 3 feet of the well annulus to anchor the protective casing. Protective posts will be installed around MW15. Protective posts are not anticipated around MW09DB but three posts will be emplaced if vehicular traffic could impact the integrity of the well.

The well will be developed in accordance with SOP-02 after removing the volume of drilling fluids lost to the formation during drilling. Dedicated, low-flow, bladder pumps will be installed in each well in accordance with SOP-07 and manufacturer's specifications prior to initiation of the sampling program.

FIGURE SOP-1-1
LOWER AQUIFER MONITORING WELL SHEET

# MONITORING WELL SHEET

| | | |
|---|---|---|
| Project: | Location: | Driller: |
| Project Number: | Well Number: | Drilling Method: |
| Elevation: | Date: | Date Completed: |
| Logged By: | | Development Method: |
| | | Date Completed: |



Key padlock type and number: ______

Elevation Top Of Casing: ______

Type of protective casing: ______

Type of surface seal: ______

Ground Elevation: ______

Surface Casing I.D.: ______

Casing Material: ______

Borehole Diameter: ______

Type of grout: ______

Depth Top of Bedrock: ______

Depth Bottom of Surface Casing: ______

Casing I.D.: ______

Casing Material: ______

Borehole Diameter: ______

Type of grout: ______

Depth top of seal: ______

Type of seal: ______

Depth top of sand pack: ______

Depth top of screen: ______

Type of screen: ______

Slot size X length: ______

I.D. of Screen: ______

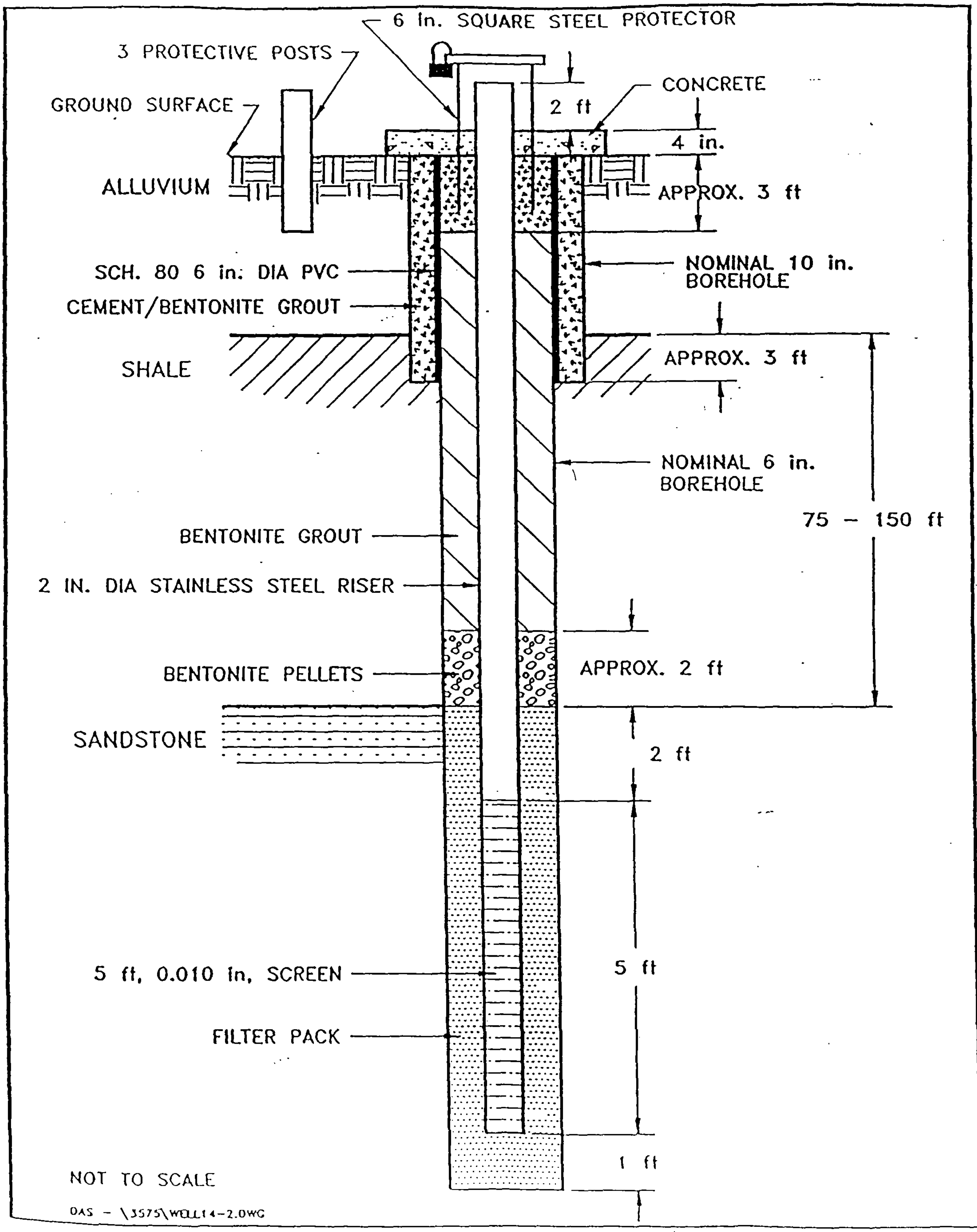
Type of sand pack: ______

Depth bottom of screen: ______

Total depth of hole: ______

DAS - WELL14-1.DWG

FIGURE SOP-1-2
LOWER AQUIFER MONITORING WELL
CONSTRUCTION DIAGRAM



# FIGURE 1-3
## METHANE MONITORING PROBE INSTALLATION REPORT

PROBE NO.: ____________________

DATE INSTALLED: ____________________

PROJECT NO.: ____________________

REFERENCE POINT EL.________FT. (AMSL)

TOP OF GROUND SURFACE EL.________FT.

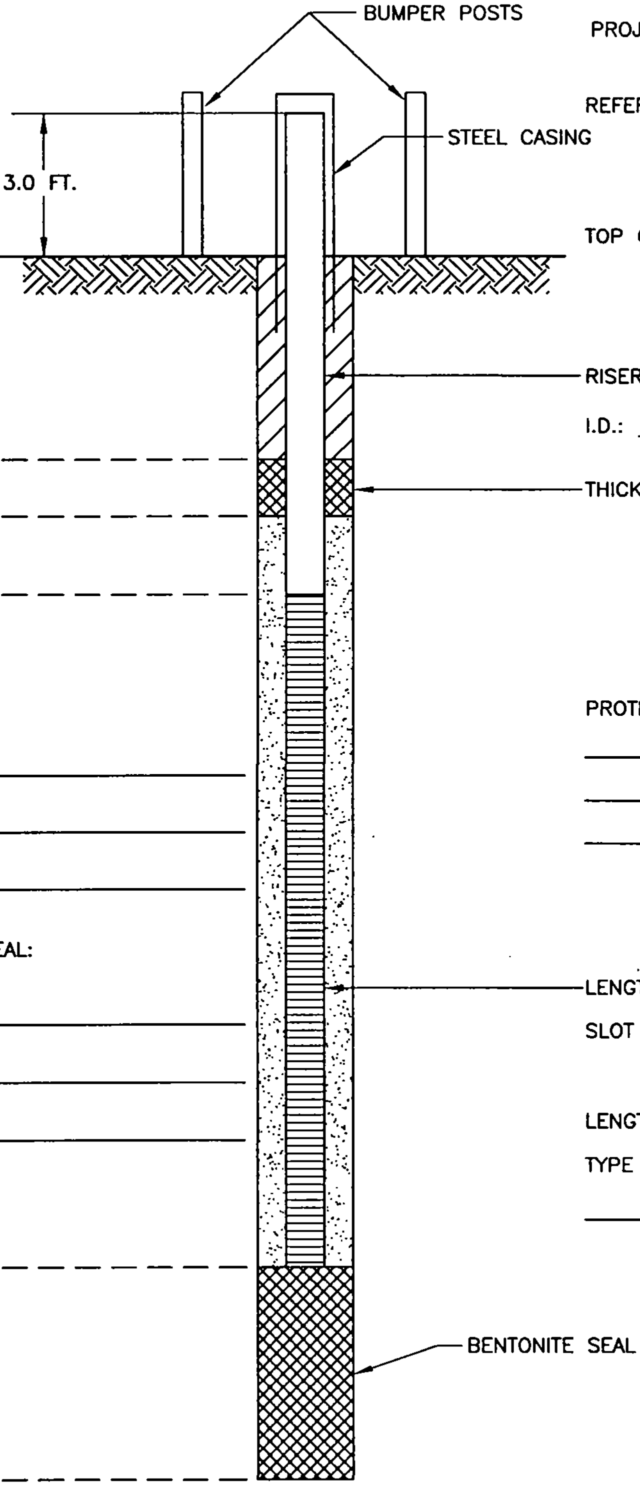
DEPTH BELOW GROUND SURFACE:

________FT.

________FT.

________FT.

________FT.




RISER PIPE SCHEDULE: ____________________

I.D.: ______________ O.D.: ______________

THICKNESS OF UPPER SEAL: ____________ FT.

GROUT MIX:

____________________

____________________

____________________

PROTECTIVE WELL CASING COVER:

____________________

____________________

____________________

BENTONITE SEAL:

____________________

____________________

____________________

LENGTH OF SCREEN: ____________ FT.

SLOT SIZE: ____________ IN.

LENGTH OF FILTER PACK: ____________ FT.

TYPE OF FILTER PACK: ____________________

____________________

________FT.

________FT.

REMARKS: ____________________

____________________

____________________

____________________

**SOP-02**
**MONITORING WELL DEVELOPMENT**

## 1.0 OBJECTIVE

Monitoring well development is the process by which the well drilling fluids and mobile particulates are removed from within and adjacent to the newly installed wells. The objective of a completed well development activity is to provide groundwater inflow that is as physically and chemically representative as possible of the aquifer that is open to the piezometer or well.

## 2.0 EQUIPMENT

The following is a list of well development and associated equipment:

- Stainless steel, Teflon® bailer or dedicated disposable bailer.
- Inertial or submersible pump.
- Water quality test kit (pH, temp, dissolved oxygen and conductivity).
- Clear plastic sheeting or vinyl sheeting which may be decontaminated.
- Disposable latex or vinyl gloves.
- Nonphosphate, lab detergent (e.g., Liquinox).
- Containers for development.
- Water level probe - sufficiently accurate to measure water levels to the nearest 0.01 foot.
- Weighted tape measure - sufficiently accurate to measure depths to the nearest 0.10 foot.
- Distilled water.
- Field book and field forms.
- Health and safety equipment.
- Calculator.

## 3.0 PROCEDURES

Perform the development as soon as practical after well installation, but no sooner than 48 hours after grouting or pad installation is completed. The equipment for well development may be an inertial pump, bottom discharge/filling bailer, or submersible pump.

The water level measurement along with the total depth measurement will be used to determine the volume of water in the well casing. Water-level measurement is described in SOP-06, Water Level Measurements. Well casing calculations are presented in Section 4.0 of this SOP.

Formation water and fines will be evacuated by vigorously lowering and raising the pump or bailer intake throughout the water column to create a surging action. Development equipment, including bailers and pumps, will be decontaminated before well development begins and between well sites according to SOP-08, Field Equipment Decontamination.

Development water will be transported to the east edge of the landfill where no waste has been identified and allowed to infiltrate.

## 4.0 DEVELOPMENT CRITERIA

Development shall proceed in the manner described herein and continue until the following are met:

- Removal of a minimum of five well casing volumes. Typical well casing volume calculations for a 2-inch well are as follows:
  0.163 gal/ft x __(linear ft of water) = gallons of water
- Record pH, temperature, and specific conductance after three consecutive well casing volume measurements (i.e., consecutive temperatures that are within 1°C, and pH readings that are within 0.2 units) and consecutive conductivity readings fall within 10 percent of each other. The calibration and use of these field instruments is described in SOP-04, Calibration and Maintenance Procedures.

- If water is used during monitoring well drilling, the total fluid added will be calculated, and the fluid lost in the borehole during drilling will be recovered in addition to the five well casing volumes.
- The sediment in the well has been removed.

## 5.0 DOCUMENTATION

The following well development information will be recorded on the Well Development Form (**Figure SOP-2-1**):

- Well I.D. and location survey coordinates.
- Date(s) of well installation.
- Date(s) and time of well development.
- Well designation.
- Screened interval.
- Well stick-up.
- Static water level from measuring point.
- Total depth from measuring point.
- Volume of well casing volume.
- Quantity of water used during drilling.
- Depth from top of well casing to top of sediment inside well, before and after development.
- Type of pump and/or bailer.
- Field measurements.
- Physical description of removed water throughout development (color and turbidity).
- Quantity of water removed and time for removal (incremental and total values).

## FIGURE SOP-2-1 WELL DEVELOPMENT FORM

Recorder's Name and Title ______
Well ID ______
Survey location coordinates: North ______ East ______
Date this report ______ Date well installation ______ Date well development ______
Well designation: ______
Ground elevation: Est: ______ Survey: ______
Screened interval: ______ Formation: ______
Measuring point (MP): Top of well casing/other: ______ Well stick up: ______
Water level (below MP): Start: ______ End: ______
Well depth (below MP): ______ Water elevation (BGS) ______
Method used to measure water level: ______ Estimated recharge rate: ______
Volume of saturated annulus (assume 30 percent porosity): ______
Volume Calculation: ______
Quantity of water used during drilling: ______
Depth of sediment (below MP): Before: ______ After: ______
Development equipment: ______
Sampling equipment: ______
pH meter No. ______ Calibration: ______
Specific conductance meter No.: ______ Calibration: ______

| Time | Pumping Rate gpm | pH | Temp. °C | S.C. umhos/cm a: °C | Cum. Vol. of $H_2O$ Removed | | Physical Description of Water |
|---|---|---|---|---|---|---|---|
| | | | | | Gallons | Casing Vols. | |
| | | | | | | | |
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Comments: ______

**SOP-03**
**SAMPLE CUSTODY PROTOCOLS AND FIELD DOCUMENTATION**

## 1.0 SAMPLE CHAIN-OF-CUSTODY PROTOCOL

Possession of samples collected in the field will be traceable from the time of collection until they are analyzed by a laboratory or disposed. Chain of custody procedures will be followed to maintain and document sample possession. A chain of custody record (**Figure SOP-3-1**) will be utilized by field personnel to document possession of all samples collected for chemical analysis. This record will include, but is not limited to, the following information:

- Project name and number.
- Name(s) and signatures of samplers.
- Sample identification number and location.
- Date and time of collection.
- Number and type of containers.
- Required analyses.
- Preservatives.
- Courier.
- Signatures documenting change of sample custody.

Chain of custody forms will accompany samples at all times. When transferring possession of the samples, the individuals relinquishing and receiving the samples will sign, date, and note the time of transfer on the record. The chain of custody will be placed in a sealed plastic bag and taped to the inside of the sample chest. The sample chest will be sealed prior to presentation to the delivery service. A commercial delivery service (i.e., Federal Express) will be identified by company name only. The delivery service is not required to sign the chain of custody. The original chain of custody which accompanies the sample to the analytical laboratory will be returned to the contractor with the analytical results and will be placed with the project file. A copy of each record will be retained by the sample custodian in the field and by the laboratory.

Samples will be tracked by the analytical laboratory in accordance with procedures specified in the Quality Assurance Project Plan.

## 2.0 PACKING AND SHIPPING PROTOCOL

This section describes packing and shipping procedures used for environmental samples. The procedures meet Department of Transportation requirements.

All samples will be classified as environmental and will be packaged using the following procedures to prevent breakage or leakage of sample container contents.

1. Check all labels for legibility and accuracy, replace labels if necessary.

2. Ensure that all labels are covered with wide cellophane tape to protect labels during shipping.

3. Visually check the outside surface of the containers for proper decontamination. If any containers appear to be soiled, decontaminate again.

4. Check all container lids and tighten if necessary.

5. Wrap sample containers with packaging material to prevent breakage during shipping.

6. Place sufficient packaging material in bottom and around the sides of the shipping cooler (sample chest).

7. Place wrapped samples in the cooler. Complete and check chain of custody forms during packaging following the protocol presented in Section 1.

8. Add ice packs to the cooler in quantities adequate to maintain 4°C temperature during shipping. If ice is used, it should be placed in sealed plastic bags.

9. Fill excess space in cooler with packing material to prevent movement of the sample containers. Styrofoam "peanuts" or other material may be used.

10. Chain of custody forms which accompany the samples to the laboratory are to be placed inside a plastic bag, sealed and taped to the inside of the cooler lid.

11. The following markings are to be placed on the top of the cooler:

    - "This End Up" labels or arrows
    - Shipper's name and address

12. The cooler is to be closed and sealed with filament tape in a manner to prevent inadvertent opening during shipment.

13. Two custody seals are to be placed on the cooler in an area that would indicate if tampering had occurred. Alternatively, lockable coolers are to be used with one custody seal.

14. A completed label for shipping by express carrier is to be attached to the top of the cooler. A copy of the shipping form is to be retained by the sample custodian.

## 3.0 SAMPLE PRESERVATION

Samples will be preserved to 4°C and kept in darkness during transport to the laboratory for analysis. Appropriate chemical preservation will be performed in the field for various test parameters at the time of sampling. Sample containers will be provided by the analytical laboratory. Each lot of sample containers will be checked for cleanliness by the laboratory and sealed to prevent contamination.

Methods of sample preservation are generally intended to; 1) retard biological action, 2) retard hydrolysis of chemical compounds and complexes, 3) reduce volatility of constituents, and 4) reduce absorption effects. Preservation methods are generally limited to pH control, chemical addition, refrigeration, and freezing. A summary of container types and preservation methods is provided in **Table SOP-7-1**.

## 4.0 SAMPLE IDENTIFICATION

A numbering system will be used to allow tracking of sample information and positive identification of sample results. Each sample number will consist of a variable code that indicates sample matrix, sampling point, sample date, and sample type.

### Sample Matrix

A two letter designation will be used to identify the specific type of sample being taken. The identifiers will consist of the following:

- DB - Deep bedrock well
- SB - Shallow bedrock well
- SG - Shallow glacial well
- WB - Weathered bedrock well
- MW- Monitoring well groundwater sample; and
- RW - Residential well groundwater sample

### Sample Point

The sample point will consist of a two digit number which will be used to identify the sample location. The sample location numbers have previously been assigned.

### Sampling Date

The sample date will be identified by a six digit date code, i.e., 101497 (October 14, 1997).

**Sample Type**

A three character code will be used to identify the sample type (i.e., investigative or QA/QC). Quality assurance/quality control samples will be given a unique sample number which corresponds with other sample identification numbers of similar sample types. The identity of the QA/QC sample will be documented on the sample field sheet and in the log book. The sample type identifiers are as follows:

- 00D - Duplicate investigative sample
- 0FB - Field blank
- 0TB - Trip blank
- 0MS - Matrix spike sample
- MSD - Matrix spike duplicate sample

An example sample identification is shown below:

- MW16DB00D101497 would indicate a duplicate groundwater sample collected from monitoring well 16 on October 14, 1997. This is a duplicate sample and MW16 is a deep bedrock monitoring well

## 5.0 SAMPLE LABELING

Following sample collection, each container will be identified by field personnel with a self-adhesive label to indicate the project name, contractor job number, sample identification number, time, date, initials of the sampler, preservative(s) added, and analysis requested. An example label is shown in **Figure SOP-3-2**.

## 6.0 FIELD DOCUMENTATION

Field activities will be documented through completion of boring logs, field sample sheets, and entries into field log books dedicated to the project. An example boring log is shown in **Figure**

**SOP-3-3**. Log books will contain information on a chronological or event-oriented basis. In general, log books will contain general site information such as:

- Site activities.
- Personnel present.
- Visitors.
- Weather conditions.
- Samples collected.
- Changes in procedures or sample locations and reason for change.

Entries will be made in waterproof ink. The pages will be sequentially numbered. The use of auxiliary data sheets, i.e., boring logs, will be referenced in the notebook. Errant entries in the log book will be stricken with a single slash mark, corrected (if necessary), and initialed.

Field documentation (field sheets, boring logs, etc. see Figure SOP 3-4) will contain, at a minimum, the following information as is applicable to the specific task at hand:

- Project name and number.
- Date/time/weather.
- Personnel present.
- Sampling location.
- Sampling method.
- Sample number.
- Sample time.
- Sample depth, total depth of boring, as appropriate.
- Visual description.
- Type of sample.
- Photo number (if applicable).
- Air quality readings (if applicable).
- Instrument calibration.
- Sample container types, shipping; and analysis.
- Other general information, and observations.

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather conditions, names of all sampling team members present, level of personal protection being used, and the signature of the person making the entry will be entered. Field sampling or investigation team personnel, the names of visitors, and the purpose of their visit to the site will be recorded in the field logbook.

All entries will be made in ink and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark and initialed by the person who made the strike. Whenever a sample is collected or a measurement is made a detailed description of the location of the station, which includes compass and distance measurements, shall be recorded. The number of the photographs taken at the station will also be noted. All equipment used to make measurements will be identified, along with the date of calibration.

# Chain of Custody Record

FIGURE SOP 3-1

| Client | Project Manager | Date | Chain Of Custody Number 10145 |
|---|---|---|---|
| Address | Telephone Number (Area Code)/Fax Number | Lab Number | Page ____ of ____ |

| City | State | Zip Code | Site Contact |
|---|---|---|---|
| Project Name | | | Carrier/Waybill Number |
| Contract/Purchase Order/Quote No. | | | |

| Sample I.D. No. and Description | Date | Time | Sample Type | Total Volume | Containers | | Preservative | Condition on Receipt | Analysis | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Type | No. | | | | | | | | | | | | | | |
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Special Instructions

| Possible Hazard Identification | Sample Disposal |
|---|---|
| ☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown | ☐ Return To Client ☐ Disposal By Lab ☐ Archive For ______ Months |

| Turn Around Time Required | QC Level | Project Specific (Specify) |
|---|---|---|
| ☐ Normal ☐ Rush | ☐ I. ☐ II. ☐ III. | |

| | Date | Time | | Date | Time |
|---|---|---|---|---|---|
| 1. Relinquished By | Date | Time | 1. Received By | Date | Time |
| 2. Relinquished By | Date | Time | 2. Received By | Date | Time |
| 3. Relinquished By | Date | Time | 3. Received By | Date | Time |

Comments

DISTRIBUTION: WHITE - Stays with Sample; CANARY - Returned to Client with Report; PINK - Field Copy

FIGURE SOP-3-2

EXAMPLE SAMPLE LABEL

| |
|---|
| WOODWARD-CLYDE CONSULTANTS |
| PROJECT: ALBION SHERIDAN TOWNSHIP LANDFILL |
| SAMPLE NO: MW01500006149300S |
| DATE: 6 June 1996 . Time: ______ |
| ANALYSIS: 40 ml vial Volatile Organics |
| PRESERVATIVE: 50% HCl |
| SAMPLERS: ______________________ |

FIGURE SOP-3-3

# LOG of BORING No.

Sheet 1 of 1

DATE ____________ SURFACE ELEVATION, FT ____________ DATUM ____________ LOCATION ____________

| DEPTH, ft. | SAMPLES | | | DESCRIPTION | | FIELD TESTS | | | NOTES |
|---|---|---|---|---|---|---|---|---|---|
| | TYPE | REC | SAMPLE | | USC | RESIST. | HNU READING | | |
| | | | | | | | SAM-PLE PPM | HEAD SPACE PPM | |
| 0 | | | | | | | | | |
| 5 | | | | | | | | | |
| 10 | | | | | | | | | |
| 15 | | | | | | | | | |
| 20 | | | | | | | | | |

Completion Depth: ____________ Water Depth: ________ ft., After ________ hrs.

Project No.: ____________ ________ ft., After ________ hrs.

Project Name: ____________ ________ ft., After ________ hrs.

Drilling Contractor: ____________ Logged by: ____________

Woodward-Clyde Consultants

Figure SOP-3-4

| GROUNDWATER SAMPLE COLLECTION FIELD SHEET | |
|---|---|
| WOODWARD-CLYDE CONSULTANTS<br>18777 W. Six Mile Road, Suite 200<br>Livonia, Michigan 48152<br>PHONE: (313) 464-1800 | PROJECT:<br>PROJECT NO:<br>LOCATION:<br>DATE SAMPLED: ________ |
| SAMPLE NO: MW __ __ - __ __ __ - __ __ __ __ | SAMPLE MATRIX: SURFACE WATER |

TIME SAMPLED: ____________

SAMPLED BY: ____________

AREA: ____________

__ SAMPLE __ DUPLICATE __ FIELD BLANK

__ MATRIX SPIKE __ MATRIX SPIKE DUPL

__ TRIP BLANK

| ANALYSIS REQUIRED | SAMPLE CONTAINER | QTY | SAMPLE PRESERVATION | X |
|---|---|---|---|---|
| | | | | |
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| | | | | |
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FIELD SCREENING

| pH: | | pH | CONDUCTIVITY: | umhos/cm |
|---|---|---|---|---|
| STANDARD | BEFORE | AFTER | STANDARD | BEFORE |
| 4.0 pH | | | 1000 umhos/cm | |
| 7.0 pH | | | | |
| 10.0 pH | | | REDOX: | |
| ALINITY: | | | TEMPERATURE: | deg C |

QA/QC DATA

| SAMPLES PACKED BY | DATE SAMPLES SHIPPED |
|---|---|
| SHIPPED TO | |

SIGNATURE(S)

**SOP-04**

# CALIBRATION AND MAINTENANCE PROCEDURES

The calibration and maintenance of instruments used to take measurements is an important aspect of the project's sampling program. As an activity which affects data quality, instrument calibration and maintenance will be performed in accordance with the instrument manufacturers specifications and established procedures by trained personnel.

## 1.0 FIELD INSTRUMENTS AND EQUIPMENT CALIBRATION

The calibration and general maintenance of field instruments is the responsibility of field team leaders or designated personnel. A field log book will be maintained by these individuals to document calibration, maintenance, and status of all instruments. The calibration record will contain, at a minimum the following information:

- Date and time of calibration
- Type of equipment and identification number
- Reference standard used for calibration
- Name of person conducting the calibration
- Results of calibration performed

A list of the field equipment scheduled for use during the investigation and the frequency of calibration and field maintenance is presented in **Table SOP-4-1**. Field calibration will be performed following the manufacturers directions and using standard solutions. Operation manuals for each piece of equipment will be kept in the field by the Site Manager or the Site Safety Officer.

Equipment that fails calibration, becomes questionable or inoperable during use will be removed from service and segregated to prevent inadvertent use. The equipment will be properly tagged to indicate that it is out of calibration. Equipment that cannot be recalibrated will be replaced.

## 2.0 PREVENTATIVE MAINTENANCE

To ensure that data generated for the project are reliable, all field equipment and instruments will have a prescribed routine maintenance schedule in addition to a calibration schedule. All field instrumentation, sampling equipment, and accessories will be maintained in accordance with the manufacturers recommendations and specifications and established field practice.

All maintenance will be performed by qualified personnel and documented by the appointed equipment manager or his designee. Documentation of maintenance performed will be similar to that for calibration and will become part of the project file. Documentation will include both scheduled and unscheduled maintenance. Unscheduled maintenance, particularly that which could have an adverse effect on field project performance, will be reported to the Field Team Leader.

The Site Manager or designee will review calibration and maintenance records on a regular basis to ensure that required maintenance is being performed as required.

**TABLE SOP 4-1**
**PREVENTIVE MAINTENANCE PROCEDURES FOR FIELD INSTRUMENTS**

| INSTRUMENT | ACTIVITY | FREQUENCY |
|---|---|---|
| Redox Meter | Check Calibration | Twice daily |
| | Clean electrode | Each use |
| pH Meter | Check Calibration | Twice daily |
| | Immerse Probe in DI water | Each use |
| | Replace Batteries | As needed |
| Dissolved Oxygen Meter | Check Calibration | Daily |
| | Clean Probe | Each use |
| | Replace Batteries | As needed |
| Specific Conductance Meter | Check Calibration | Twice daily |
| | Clean Probe | Each use |
| | Replace Batteries | As needed |
| Thermometer | Inspect Instrument for change | Daily |
| | Replace Batteries (if digital) | As needed |

**SOP-05**

**QUALITY ASSURANCE/QUALITY CONTROL SAMPLING**

---

## 1.0 DUPLICATE SAMPLES

Duplicates of selected samples will be collected and analyzed to check for sampling and analytical reproducibility and field representativeness. Duplicates will be collected by alternately filling the set of sample containers incrementally with equal volumes until all are full. As an example of this, a set consisting of four containers (sample plus duplicate) would be prepared by placing an equal volume of water into each container. The sampling device (dipper, bailer, etc.) is then refilled and the procedure repeated until each container is full. For volatile organic analysis (VOA) of water samples, each VOA vial will be filled separately.

## 2.0 BLANK SAMPLES

Blank samples will be analyzed to check for ambient conditions at the site that may cause sample contamination (trip blank).

Field Blank

Field blanks will not be collected for groundwater samples obtained using a bladder pump.

Trip Blank

A trip blank for volatile organic analyses (VOA) will be included in each sample shipment containing water samples for volatile organics analyses. The trip blank will consist of one or more 40 ml VOA vials filled with Milli-Q water. They will be prepared in the laboratory, transported to the field, and shipped with the other samples to the laboratory without being opened in the field. The trip blank will be documented on the chain of custody form for samples sent to the laboratory. One of the trip blank vials will then be analyzed for volatile organics.

## 3.0 MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES

Matrix spike/matrix spike duplicate (MS/MSD) samples will be collected and analyzed to evaluate the effect of the sample matrix on the accuracy of the analysis. MS/MSD samples will be analyzed for organics only. Triple the normal volume of sample is required for volatile and semi-volatile organics.

**SOP-06**

**WATER LEVEL MEASUREMENTS**

## 1.0 OBJECTIVE

This document defines the standard procedure for measuring water levels in wells. This procedure describes equipment and field procedures necessary to collect water level measurements. SOP-8 describes decontamination procedures which are applicable to this SOP.

## 2.0 EQUIPMENT

The equipment necessary to measure water levels includes:

- Well keys
- Solinst Model 101 water level meter or equivalent resistivity type meter
- Two 5-gal buckets (with lids) or equivalent for decontamination
- Decontamination brushes
- Alconox soap
- Deionized or distilled water
- Potable water
- Spray bottle
- Field data sheets
- Field notebook
- Appropriate health and safety equipment

## 3.0 PROCEDURE

This section gives the sequence of events to follow when measuring water levels. Appropriate health and safety equipment, as described in the Health and Safety Plan (HASP) should be worn during well opening, well measurement, and decontamination.

- The water level probe shall be decontaminated prior to use in each monitoring well.

- Observations concerning the well pad, surface or protective casing and other well conditions will be documented in the field notebook.

- The depth of the static water level and the total depth of the well will be measured using an electric water level meter. The measuring point for all the wells shall be the top of monitoring well casing. If a reference mark is not found, then all well readings will be referenced to the north rim of the monitoring well riser pipe for standardization.

- The static water level and the total depth of the well shall be measured, recorded on the water level data sheet, and then immediately rechecked.

- All columns of field data sheets shall be completed, including time of measurement. If measurements are taken over a several-day period, the date of each measurement should be clearly indicated on the form.

- Care shall be taken to verify the readings during each water level measurement period. Any significant changes in water level will be noted by comparing the most recent measurement with past measurements.

- After any measurement is taken, the water level probe shall be decontaminated.

## 3.1 DECONTAMINATION

The water level indicator must be decontaminated before use, between wells, and at the conclusion of measurements. The probe will be decontaminated according to the procedure for decontamination of sampling equipment described in SOP-8.

## 4.0 DOCUMENTATION

Field data sheets or field notebooks will include date, time, well number, total well depth, water level, static water elevation, and comments. The data sheets or notebook shall be neat and legible, and shall be signed and dated by the person completing the page.

**SOP-07**
**GROUNDWATER SAMPLING**

---

## 1.0 OBJECTIVE

This document defines the standard procedure for collecting groundwater and surface water samples. This procedure gives descriptions of equipment, field procedures, and QA/QC procedures necessary to collect groundwater and surface water samples. The sample locations and frequency of collection are specified in the Remedial Action PMP.

This SOP is intended to be used together with the PMP and several other SOPs. Health and safety procedures and equipment that will be required during the investigation will be detailed in the Site Health and Safety Plan (HASP).

## 2.0 EQUIPMENT

Equipment used during well purging:

- Well keys.
- Electronic water level probe.
- Assorted tools (knife, screwdriver, etc.).
- Bailer.
- Low-flow Bladder Pump (Well Wizard pump).
- Pump discharge hose (with Well Wizard).
- Thermometer.
- pH meter (with automatic temperature compensation).
- Conductivity meter.
- Plastic squeeze bottle filled with deionized water.
- Polyethylene or glass container (for field parameter measurements).
- Paper towels or Kimwipes.
- Calculator.

- Field notebook.
- Waterproof and permanent marker.
- 55-gallon drum or holding tank for storing purged water.
- Appropriate health and safety equipment.
- Well completion information sheet.
- Appropriate decontamination equipment.

Equipment used during well sampling:

- Electronic water level measurement probe.
- Low-flow bladder pump (Well Wizard pump).
- Bailer.
- Thermometer.
- pH meter (with automatic temperature compensation).
- Conductivity meter.
- Redox potential equipment.
- Plastic squeeze bottle filled with distilled or deionized water.
- Cooler with ice.
- Polyethylene or glass jar for measurement of field parameters.
- Sample jars and labels. Sample bottles with preservatives added will be obtained from the analytical laboratory. Several extra sample bottles will be obtained in case of breakage or other problems.
- Peristaltic pump, dedicated tubing and dedicated disposable 45 -micron sterile filters.
- Paper Towels.
- Field notebook.
- Water sample collection form.
- Waterproof and permanent marker.
- Well completion information sheet.
- Appropriate decontamination equipment.
- Appropriate health and safety equipment.

## 3.0 PROCEDURE

This section gives the step-by-step procedures for collecting groundwater samples in the field. Observations made during sample collection should be recorded in the field notebook and field data sheet.

## 3.1 EQUIPMENT DECONTAMINATION

Before any purging or sampling begins, all well probes, bailers, and other sampling devices shall be decontaminated. If dedicated equipment is used, it should be rinsed with distilled water. Mobile decontamination supplies will be provided so that equipment can be decontaminated in the field. Each piece of purging or sampling equipment shall be decontaminated before sampling operations and between each well. The decontamination solutions shall be replaced with clean solutions between each well.

## 3.2 INSTRUMENT CALIBRATION

Electronic equipment used during sampling includes a pH meter with temperature scale and automatic temperature compensation, a conductivity meter, and a water level measurement probe. Before going into the field, the sampler shall verify that these instruments are operating properly. The pH and conductivity meters require calibration prior to use every day and must be recalibrated if they have been turned off. Calibration times and readings will be recorded in a notebook to be kept by the field sampler.

## 3.3 WELL PURGING

The purpose of well purging is to remove stagnant water from the well and obtain representative water from the geologic formation being sampled while minimizing disturbance to the collected samples. A dedicated low-flow (< 0.5 liter/min) pump will be installed in accordance with the manufacturer's recommended procedures for purging/sampling during the O&M monitoring program.

Before a sample is taken, the well will be purged until either:

1) a minimum of three to five well casing volumes have been removed using a low-flow Well Wizard pump.
2) field parameters have stabilized.

Evacuated well water will be discharged back down the well it originated from following completion of all purging/sampling activities.

The following procedures will be performed at each well:

- The condition of the outer well casing, concrete well pad, protective posts (if present), and any unusual conditions of the area around the well will be noted in the field logbook.

- The well will be opened.

- The condition of the inner well cap and casing will be noted.

- The depth of static water level will be measured (to nearest 0.01 foot) and recorded from the measuring point on the well casing, the measuring point (e.g., notch on north side, top of well casing) identified, and time indicated.

- The total depth of well from the same measuring point on the casing will be measured and recorded.

- The volume of water in the well casing will be calculated in gallons based on feet of water and casing diameter.

- From the above calculation, the three to five casing volumes to be evacuated will be calculated.

- An initial sample will be obtained from the purge pump for field measurements of temperature, conductivity, and pH, and for observation of water quality. This sample will not be retained after these initial measurements are recorded.

- Water in casing will be evacuated with a pump. Temperature, conductivity, and pH measurements will be taken after evacuation of each well volume to determine whether the water chemistry has stabilized. Generally, pH values within $\pm 0.1$ pH unit, temperature within $\pm 0.5$°C, and conductivity within $\pm 10$ µmhos/cm between consecutive readings indicate adequate stability of the water chemistry. If the chemistry is not stable, purging will continue, measuring pH and conductivity after each one-half well volume.

- Following stabilization, the remaining field parameters will be measured.

### 3.4 SAMPLE COLLECTION

Samples for chemical analysis will be collected within two hours after purging is completed. If samples are not taken immediately after purging (but within the two-hour limit) an additional one to two well volumes will be purged prior to sampling. For slow recovering wells, the sample shall be collected immediately after a sufficient volume is available. The water quality samples shall be taken from within the well screen interval. The following sampling procedure is to be used at each well:

1. Decontaminated or dedicated sampling equipment will be assembled.

2. Sample collection:

When Well Wizard is used for water sample collection:

- Purge Saver will be connected to the hose from the low-flow bladder pump.

- Low-flow bladder pump will be turned on.

- Purge parameters including temperature, pH and conductivity will be measured periodically until these parameters have stabilized readings. Remaining field parameters will be measured.

3. The individual sample bottles should be filled in the order given below:

   a) Volatile organic compounds (VOCs), if any
   b) Semivolatile organic compounds (SVOCs), if any
   c) Metals

   VOC sample vials should be completely filled so the water forms a convex meniscus at the top, then capped so that no air space exists in the vial. Turn the vial over and tap it to check for bubbles in the vial which indicate air space. If air bubbles are observed in the sample vial, discard the sample vial and repeat the procedure until no air bubbles appear.

   Filtered samples for metals will be collected in designated vials that contain appropriate preservatives.

   For samples requiring filtered analysis for metals, water aliquot will be field filtered using a 45 micron sterile filter prior to preserving and placement in to the appropriate sample bottle. Disposable filter units will be used to minimize potential cross contamination.

   Fill bottles for metals and water quality almost full.

   Bottles will have preservatives added in the laboratory prior to shipment to the site and so labeled.

4. Identification labels for sample bottles will be filled out for each well.
5. Time of sampling will be recorded.
6. The well cap will be replaced and locked.

7. Field documentation will be completed, including the chain-of-custody.

## 3.5 FIELD QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES AND SAMPLES

Field QA/QC samples are designed to help identify potential sources of sample contamination and evaluate potential error introduced by sample collection and handling. All QA/QC samples are labeled with QA/QC identification numbers and sent to the laboratory with the other samples for analyses.

Field Blanks

Field blanks will not be collected for samples obtained using a dedicated bladder pump.

Duplicate Samples

Duplicate samples are samples collected side-by-side to check for the natural sample variance and the consistency of field techniques and laboratory analysis. For the groundwater sampling a duplicate sample will be collected at the same time as the initial sample. The initial sample bottle for a particular parameter or set of parameters will be filled first, then the duplicate sample bottle for the same parameter(s), and so on until all necessary sample bottles for both the initial sample and the duplicate sample have been filled. The duplicate groundwater sample will be handled in the same manner as the primary sample. The duplicate sample will be assigned a QA/QC identification number, stored in an iced cooler, and shipped to the laboratory on the day it is collected.

Matrix Spikes and Matrix Spike Duplicates

Matrix spikes are used to determine long-term precision and accuracy of the laboratory analytical method on various matrices. For this procedure duplicate samples are collected at the well and spiking is done by the lab. Samples are labeled as matrix spikes for the lab. The matrix spike and duplicate will be collected at the same well.

## 4.0 SAMPLE IDENTIFICATION AND HANDLING

Samples will be identified, handled, and recorded as described in SOP-03.

## 5.0 DOCUMENTATION

### 5.1 FIELD SAMPLING DATA SHEET

A field sampling data sheet for groundwater samples (**Figure SOP-3-4**) will be completed at each sampling location. The data sheet will be completely filled in. If items on the sheet do not apply to a specific location, the item will be labeled as not applicable (NA). The information on the data sheet includes the following:

- Well number.
- Date and time of sampling.
- Person performing sampling.
- Volume of water purged before sampling.
- Conductivity, temperature, and pH during evacuation (note number of well volumes).
- Redox potential.
- Number of samples taken.
- Sample identification number.
- Preservation of samples.
- Record of any QC samples from site.
- Any irregularities or problems which may have a bearing on sampling quality.

### 5.2 FIELD NOTES

Field notes shall be kept in a bound field book. The following information will be recorded using waterproof ink:

- Names of personnel.
- Weather conditions.
- Location and well number.

- Date and time of sampling.
- Condition of the well.
- Decontamination information.
- Initial static water level and total well depth.
- Calculations (e.g., calculation of purged volume).
- Analyses that will be performed by the laboratory.
- Equipment calibration information.

## 5.3 WELL VOLUME CALCULATIONS

The following equation shall be used to calculate the volume of water to be removed during well evacuation:

For 2-inch well:

Evacuation Volume = (Total Well Depth (ft) - Water Level Depth (ft)) x 0.163 gal/ft = gallons/1 well casing volume

Multiply the volume of one well casing volume by three (3) to obtain the minimum volume of water to be evacuated.

## 6.0 CALIBRATION

## 6.1 pH METER

The pH meter must be calibrated each day before taking any readings of samples and must be recalibrated during the day if it has been turned off after the initial calibration. Calibration and operation of the pH meter will follow the manufacturer's specific instructions. In general, calibration is done by adjusting the meter with standard buffers that bracket the expected pH of the field water. The buffers to be used are pH 4.0, 7.0, and 10.0. Calibration will consist of the following general procedures:

1. Adjust the reading of the pH meter using the intercept knob with the electrode placed in the pH buffer by using the calibration knob. Rinse the electrodes with distilled water between buffer adjustments.

2. With the electrode placed in another pH buffer, adjust the reading of the meter with the slope knob. Adjust using the temperature knob if the meter has no slope knob.

3. Repeat steps 1 and 2 until the meter gives acceptable readings ($\pm$0.1 pH unit) for all the buffers used for calibration.

Note: Always use the same electrode for measurements that was used in the calibration. Recalibrate the meter if the electrode is replaced. Although the temperature setting on the pH meter often does not match the sample temperature after calibration, the pH readings will still be accurate in these cases provided that the response to the buffers is correct.

Record the time of analysis and temperature of the buffer in the field notebook whenever the pH meter is calibrated.

## 6.2 CONDUCTIVITY METER

The conductivity meter must be calibrated each day before taking field measurements. Record time, temperature, and instrument response in the meter notebook. Calibration is done by noting the response of the meter to several standard conductivity solutions which bracket the values expected to be measured in the field. A standards of 1000 µmhos/cm should be adequate for the samples expected. If the instrument has a calibration adjustment, set the response to match the standards. Otherwise, simply record in the field notebook the instrument response to each standard.

## 6.3 REDOX POTENTIAL METER

The redox potential meter must be checked for proper operation each day before taking field measurements. The redox potential meter is checked for sensitivity using buffer solution recommended by the manufacturer. Record time and instrument response in the meter field note book.

TABLE SOP 7-1
CONTAINER, PRESERVATION, AND HOLDING TIME REQUIREMENTS
FOR WATER SAMPLES

| PARAMETER | MATRIX | MINIMUM SAMPLE SIZE | CONTAINER | FIELD SAMPLE PREPARATION | SAMPLE PRESERVATION | HOLDING TIME |
|---|---|---|---|---|---|---|
| Filtered Metals | Water | 500ml | 1000ml Poly | Filtration | $HNO_3$ to pH<2,4C | 6 Months* |
| Volatile Organics | Water | 120ml | 3-40ml VOA vial | None | 4C<br>4 drops Conc. HCL<br>pH<2,4C | 14 Days |
| Total Chromatographic Organics | Water | 1L | 1L Glass Jar | None | 4C | 14 Days, 40 Days** |
| Conductivity | Water | 50ml | 500ml | Field Procedure | NA | Field Procedures |
| pH | Water | 50ml | 500ml Glass or Poly | Field Procedure | NA | Field Procedures |
| Temperature | Water | 100ml | Glass or Poly | Field Procedure | NA | Field Procedures |
| Redox | Water | 100ml | 500ml Glass or Poly | Field Procedure | NA | Field Procedures |

Notes:

* Filtered metals holding time from sample date to analysis.

** Semivolatiles holding times from sample date to extraction and from extraction to analysis.

**SOP-08**
**FIELD EQUIPMENT DECONTAMINATION**

---

## 1.0 OBJECTIVE

Decontamination of personnel and equipment will be performed to limit the transport of contaminants to personnel to off-site areas and between work areas. Personnel decontamination protocol will be presented in the Health and Safety Plan. All sampling equipment coming in contact with soils, sediment, groundwater and surface water will be decontaminated prior to sampling, between sampling locations, between boring intervals, and at the completion of work. The objective of the procedure is to minimize the potential for cross-contamination of samples and accumulation of erroneous data.

## 2.0 EQUIPMENT

Decontamination equipment and supplies consist of the following:

- Potable water
- Wash tubs
- Alconox (or equivalent)
- Scrub brushes
- Hot water or high pressure
- Plastic sheeting
- Saw horses or pallets
- 5 gal buckets
- Garbage bags
- Distilled water
- Hand spray bottle
- Methanol
- Sprayer

## 3.0 GENERAL

Decontamination of heavy equipment will occur in the main decontamination area. This area will be established for cleaning of augers, drill bits, drill rig, backhoe, large tools, and other large items.

Personnel and small sampling and field equipment decontamination may be performed outside the sampling locations or at the main decontamination area.

## 4.0 PROCEDURES

Small equipment will be cleaned using the following equipment procedures:

- Scrub with brush using Alconox soap (or equivalent) and potable water solution.
- Water rinse.
- Air dry.
- Place sampling equipment into new plastic bags (if necessary to store).

For removal of heavily-oiled residues, a methanol wash may optionally be included prior to the final distilled water rinse. This rinsate will be collected.

Large equipment will be decontaminated using procedures outlined below.

- Move equipment to designated area.
- Clean equipment using a high pressure or hot water wash. Scraping and scrubbing may be necessary to remove encrusted material. Items should be placed on saw horses or pallets to prevent contact with the ground.
- Place equipment on saw horses or pallets and allow to dry; protect against airborne dust or spray water cross-contamination.
- Decontaminated equipment (augers, drill rods, and associated equipment) will be stored on a clean decontaminated trailer.
- Sampling and field equipment should not come in contact with potential sources of contamination prior to moving to the next sample location.

## 5.0 HANDLING OF DECONTAMINATION FLUIDS

Equipment decontamination and monitoring well development fluids will be transported to the State of Michigan property located to the southeast of the landfill property as priorly approved and allowed to infiltrate.

**SOP-09**

**AMBIENT AIR SAMPLING/GAS VENT SAMPLING**

---

## 1.0 OBJECTIVE

This procedure describes equipment and field procedures necessary for collecting ambient air samples at the site.

## 2.0 EQUIPMENT

The following is a list of equipment that will be necessary to collect ambient air samples.

- Field Logbooks
- SUMMA canisters
- Vacuum gauges, filters, and pre-set 24 hour flow controllers, for SUMMA canisters
- Sample shipping containers

## 3.0 PROCEDURE

This section presents the procedures for collecting ambient air samples at the property fence line and gas vent opening. Appropriate health and safety equipment as described in the Health and Safety Plan, will be worn while sampling.

- Place a laboratory-provided SUMMA canister at the desired sampling location.
- Complete the canister assembly by attaching a filter, a vacuum gauge and a flow controller according to the laboratory directions.
- Record the initial vacuum and serial number of the canister. The initial vacuum should be 28-inch Hg or above. Open the SUMMA canister valve to allow gas to be drawn into the canister.

- The canister pressure should be checked during the sampling interval. Since the volume sampled is a linear function of pressure, the pressure in the canister will be monitored to assure that at the end of the 24 hour sampling period, at least 5 inches of mercury (pressure) remain in the canister.
- When sampling is completed, close canister valve and record the final vacuum pressure.
- Label the SUMMA canister with the collection time, date, sample number, and initial and final vacuum readings. Complete the chain-of-custody and store the canister in the laboratory supplied storage box.

**SOP-10**

**GAS MONITORING PROBE SAMPLING**

## 1.0 OBJECTIVE

This procedure describes equipment and field procedures necessary for collecting methane samples at the gas monitoring probes and gas vent openings.

## 2.0 EQUIPMENT

The following is a list of equipment that will be necessary to sample gas monitoring probes.

- Field Logbooks
- Combustible Gas Indicator
- Landfill Gas Monitoring Form

## 3.0 PROCEDURE

This section presents the procedures for measuring landfill gas parameters at the gas monitoring probes. Appropriate health and safety equipment as described in the Health and Safety Plan, will be worn while sampling.

- Calibrate meter according to manufacturers specifications.
- Insert probe in vent opening.
- Open probe seal and immediately record the readings for methane, oxygen and hydrogen sulfide concentrations. In addition to measuring the concentration of landfill gas components, ambient temperature, barometric pressure and rainfall quantities (36 hours prior to sampling) will be collected.
- When sampling is completed, verify accuracy with calibration gas.

**TABLE SOP 10-1**
**LANDFILL GAS MONITORING FORM**

Date__________ Time__________ Temperature__________

Barometric Pressure__________ Weather Conditions__________________________

Rainfall (preceding 36 hours)__________

Monitoring Technician__________________________________

| Vent No. | Probe Pressure | Methane Concentration | $H_2S$ Concentration | $O_2$ Concentration | Comments |
|---|---|---|---|---|---|
| | | | | | |

E

**APPENDIX E**
**FINAL REPORT**

# CONTRACT SPECIFICATIONS

# ALBION SHERIDAN TOWNSHIP LANDFILL CALHOUN COUNTY, MI

*Prepared for*
Cooper Industries
Houston Texas

and

Corning, Inc.
Corning, New York

August, 1997

Woodward-Clyde

38777 West Six Mile Road
Suite 200
Livonia, Michigan 48151
6E13045

# TABLE OF CONTENTS

# SECTION 01011
# SUMMARY OF PROJECT

## PART 1 GENERAL

### 1.01 INTRODUCTION

A. The purpose of the Albion-Sheridan Township Landfill remedial action construction is to provide an environmentally acceptable cover system with stormwater, erosion and landfill gas controls. This specification addresses the construction of the remedial action. The landfill is located in Calhoun County, Michigan, east of the town of Albion.

B. There are several site-specific factors which need to be taken into account for the successful completion of this project. The Contractor shall use these conditions as guidelines for execution of the Work.

C. Definitions:

1. Group

| | |
|---|---|
| Cooper Industries | Corning. Inc. |
| P.O. Box 4446 | HP-ME-03-055-B12 |
| Houston, Texas 77210 | Corning, NY 14831 |

2. Engineer:
Woodward-Clyde Consultants
6465 Wayzata Boulevard, Suite 660
Minneapolis, Minnesota 55426
3. Technical Representative:
Woodward-Clyde Consultants
4. Project Manager:
Mr. Robert G. Gibson - Woodward-Clyde Consultants

## 1.02 HEALTH AND SAFETY CONSIDERATION

A. The Contractor shall be prepared to implement the Work in a fashion which is protective of site workers and the surrounding community. The Contractor shall design a site health and safety plan which will be submitted to the Engineer for review. Section 01450, Health and Safety, describes the requirements.

## 1.03 GENERAL DESCRIPTION OF WORK

A. The landfill area currently containing wastes is approximately 16.5 acres and lies east of Albion, Michigan. The site access is from Erie Road on the southeast corner of the property. Keys for the access gate will be submitted to the Contractor Project Manager for use during construction.

B. According to preliminary estimates, the landfill contains as many as 200 to 400 drums of unknown liquids and solids that will require excavation, removal, overpacking, content characterization and disposal. Air monitoring will be required in conjunction with the other health and safety precautions specified in Section 01450.

C. Approximately 50,000 cubic yards of waste materials shall be excavated from the eastern perimeter area of the landfill, moved and placed in the main fill area. On-site air monitoring shall be performed by the Contractor during the period of waste excavation, movement and placement. Requirements of the air monitoring activities to be performed by the Contractor are specified in Section 01450, Health and Safety.

D. The landfill cover system will be placed over the re-graded landfill surface as indicated on the Drawings. It will consist of gas collection/foundation layer fill, 40 mil linear low density polyethylene geomembrane, drainage net, cover soil layer fill and a topsoil layer. Stormwater diversion berms will be used to direct stormwater runoff to infiltration basins as shown on the Drawings. The various landfill cover system components shall be graded such that each layer will meet thickness requirements indicated on the Drawings, at a minimum, and such that the topsoil layer, at the time of completion, will meet the lines, grades and dimensions shown on the Drawings. The topsoil layer will be vegetated by the Contractor after grading is completed.

E. Rough grading to the grades as shown on the Drawings are to be accomplished with a minimum amount of excavation. Movement of waste is expected to accomplish the grades shown on the Drawings for this site. Shaping of the landfill surface (rough grading) involves smoothing and shaping existing slopes to minimize sharp grade changes, eliminate depressions and achieve minimum grades. Grades for the landfill surface will vary between a minimum of 4% and a maximum of 25%.

F. Other work to be performed as part of this Contract will include the following:

1. Mobilization and demobilization from the site
2. Health and Safety
3. Dust control
4. Site clean-up
5. Borrow area development and restoration
6. Surveying
7. Construction facilities
8. Other work described in the Contract Documents

E. The Drawings and Specifications describe performance of the Work and will be used as the basis for acceptance of the Work.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION (NOT USED)

**END OF SECTION**

# SECTION 01139
# MEETINGS

## PART 1 GENERAL

### 1.01 REQUIREMENTS INCLUDE

A. A pre-construction meeting shall be held at a location to be determined by the Engineer. The pre-construction meeting shall be attended at a minimum by the Group, Engineer, Project Manager, Contractor's Project Manager, Contractor's Superintendent, Contractor's Safety Officer, EPA and MDEQ. The Engineer shall be responsible for developing and reproducing the meeting agenda and also the minutes for distribution to the involved parties.

B. The Contractor shall schedule and administer progress meetings at a minimum of once per week and such additional meetings as required, if requested by Owner or Engineer. Progress meetings shall be scheduled for the same day and time each week. The Engineer shall be notified a minimum of 24 hours in advance of any variation in this schedule.

C. The progress meetings shall be attended a minimum by the Engineer, Contractor's Superintendent, Contractor's Safety Officer, and Subcontractors and Suppliers as appropriate to the agenda.

D. The Contractor shall prepare agenda for meetings, make physical arrangements for meetings, and record the minutes including significant proceedings and decisions.

E. The Contractor shall reproduce and distribute copies of minutes within three (3) calendar days after each meeting to participants in the meeting and to parties affected by decisions made at the meeting. Three (3) copies of the minutes shall be furnished to the Engineer.

## 1.02 MEASUREMENT AND PAYMENT

A. No quantity measurement or separate payment will be made for the Work performed for Progress Meetings as described in this Section. Costs for Progress Meetings shall be included in the Mobilization price.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION (NOT USED)

****END OF SECTION****

# SECTION 01300

# SUBMITTALS

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Submittal procedures.

B. Proposed products list.

C. Product Data, Shop Drawings, and Samples.

D. Miscellaneous Submittals:

1. Construction Permits.
2. Manufacturers' Instructions.
3. Manufacturers' Certificates.
4. Construction Photographs.

### 1.02 RELATED SECTIONS

A. SECTION ____________ - General Conditions

### 1.03 CONFLICTS

A. In the event of conflict between this Section and the General Conditions, the more restrictive requirements shall apply.

## 1.04 DEFINITIONS

Work-related submittals of this Section are categorized for convenience as follows:

A. Product Data: Product Data include standard printed information on materials, products and systems not specially prepared for the Work, other than designation of selections from among available choices printed therein.

B. Shop Drawings: Shop Drawings include specially prepared technical data for the Work, including drawings, diagrams, performance curves, data sheets, schedules, templates, patterns, reports, calculations, instructions, measurements and similar information not in standard printed form for general application to other contracts.

C. Samples: Samples include both fabricated and unfabricated physical examples of materials, products and units of Work; both as complete units and as smaller portions of units of Work; either for limited visual inspection or (where indicated) for more detailed testing and analysis.

D. Miscellaneous Submittals: Miscellaneous Submittals related directly to the Work (non-administrative) include construction permits, warranties, maintenance agreements, workmanship bonds, project photographs, survey data and reports, physical Work records, quality testing and certifying reports, copies of industry standards, records, drawings, field measurement data, operation and maintenance materials, overrun stock; and similar information, devices and materials applicable to the Work and not processed as Product Data, Shop Drawings or Samples.

## 1.05 QUALITY ASSURANCE

A. The Engineer shall review submittals only for general conformance with the design concept. Such review by the Engineer shall not relieve the Contractor or any subcontractor of responsibility for full compliance with Contract requirements; for correctness of dimensions, clearances and material quantities; for proper designing of details; for proper fabrication and construction techniques; for proper coordination with other trades; and for providing all devices required for safe and satisfactory construction and operation.

B. Submittals reviewed by the Engineer and returned to the Contractor will be marked with one of the following designations:

1. No Exceptions Taken
2. Furnish As Noted
3. Revise and Resubmit

C. The Contractor shall not proceed with procurement, manufacture or fabrication of items for review until such submittals have been designated by the Engineer as "No Exceptions Taken" or "Furnish As Noted", unless specifically authorized to do so by the Engineer.

D. Processing of Accepted Submittals:

1. Each copy of the submittal so designated by the Engineer will be identified accordingly by being so stamped and dated.
2. One reproducible copy will be returned.
3. Construction shall be carried out in accordance therewith and no further changes made therein except upon written instructions from the Engineer. Final drawings and microfilms shall be submitted to the Engineer as specified in these Contract Documents.

E. Processing of Submittals not Excepted:

1. If corrections to the submittals are required, one reproducible copy will be returned to the Contractor for correction.
2. Resubmissions will be handled in the same manner as first submissions. Direct specific attention, in writing or on resubmittals, to revisions other than the corrections requested by the Engineer on previous submittals using the notation specified in Paragraph 3.1.A.

3. The Contractor shall promptly notify the Engineer if any correction indicated on submittals constitutes a change of the Contract requirements.

4. Work indicated on submittals marked "Approved as Noted" may be carried out prior to resubmission and final review.

## 1.06 SUBMITTAL SEQUENCING AND SCHEDULING

A. Coordinate preparation and processing of submittals with performance of the Work so that Work will not be delayed by submittals.

B. Coordinate and sequence different categories of submittals for the same Work, and for interfacing units of Work, so that one will not be delayed for coordination with another.

C. The Contractor shall make all submittals far enough in advance of scheduled installation dates to provide all time required for reviews, for possible revisions and resubmittals, and for placing orders and securing delivery.

D. Timing of submittals shall allow for review time as stipulated in the General Conditions.

## 1.07 CONSTRUCTION PROGRESS SCHEDULES

A. Submit initial progress schedule in duplicate within 10 days after award of contract for Engineer review.

B. Revise and resubmit as required.

C. Submit revised schedules with each Application for Payment, identifying changes since previous version.

D. Submit a horizontal bar chart with separate line for each section of Work, identifying first work day of each week.

E. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate the early and late start, early and late finish, float dates, and duration.

F. Indicate estimated percentage of completion for each item of Work at each submission.

# PART 2 PRODUCTS (Not Used)

# PART 3 EXECUTION

## 3.01 SUBMITTAL PROCEDURES

A. All submittals shall be transmitted with pre-printed letter of transmittal form of Contractor's choosing, dated and signed, with the job title and Section(s) of the Specification requiring the submittal clearly indicated. The forms shall be sequentially numbered. Resubmittals shall have the original number together with an alphabetic suffix (A, B, ...) indicating the number of resubmittals.

B. By signing the submittal, the Contractor shall certify that review, verification of products required, field dimensions and coordination of information is in accordance with the Work as specific in the Contract Documents.

C. Submittals shall be processed in accordance with the General Conditions.

D. Identify variations from the Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed Work.

E. Provide space for the Contractor's and Engineer's review stamps. Submittal shall contain Contractor's executed review and approval marking. Submittals which are received from sources other than through Contractor's office will be returned "without action."

F. Revise and submit resubmittal as required and identify all changes made since the previous submittal. Submission of resubmittals shall be performed in a similar manner as that of the submittals described in Paragraph 1.06 of this Specification.

G. Distribution:

1. Distribute copies of reviewed submittals to all subcontractors whose work will interface with the subject of the submittal.
2. Provide additional distribution of submittals (not included in other copy submittal requirements specified in this Section) to subcontractors, suppliers, fabricators, installers, governing authorities and others as necessary for performance of the Work.
3. Include such additional copies in transmittal to Engineer where required for status before final distribution, and show such distribution on transmittal form.

**3.02 PROPOSED PRODUCT LIST**

A. Within 20 days from execution of the agreement between the Group and Contractor, submit complete list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

B. For products specified only by reference standards, give manufacturer, trade names, model or catalog number, and reference standard.

**3.03 PRODUCT DATA, SHOP DRAWINGS, AND SAMPLES**

A. Product Data:

1. Collect required data into one submittal for each unit of Work or system; and mark each copy to show which choices and options are applicable to the Work. Include manufacturer's standard printed recommendations for application of labels and seals, notation of field measurements which have been checked, and special coordination requirements.

2. Maintain one set of Product Data (for each submittal) at project site, available for reference by Engineer and others.
3. Submit number of copies as required by the General Conditions.
4. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide all information unique to this Project.
5. After review, distribute in accordance with Article 3.1.

B. Shop Drawings:

1. Comply with the General Conditions.

C. Samples:

1. Provide units identical with final condition of proposed materials or products for the Work.
2. Include "range" samples (not less than three units) where unavoidable variations must be expected, and describe or identify variations that must be expected, and describe or identify variations between units of each set.
3. Provide full set of optional samples where Engineer's selection is required. Prepare samples to match Engineer's sample where so indicated.
4. Include information with each sample where so indicated. Include information with each sample to show generic description, source or product name and manufacturer, limitations, and compliance with standards. Samples are submitted for review and confirmation of color, pattern, texture, and "kind" by Engineer.

5. Engineer will not "test" samples (except as otherwise indicated) for compliance with other requirements, which are therefore the exclusive responsibility of the Contractor.

## 3.04 MISCELLANEOUS SUBMITTALS

A. Construction Permits:

1. Acquire, maintain, and submit copies of all construction permits that are required by the agencies to execute the Work.

B. Manufacturers' Instructions:

1. When specified in individual specification Sections, submit manufacturers' printed instructions for delivery, storage, assembly, installation, start-up, adjusting and finishing in quantities specified herein.
2. Identify conflicts between manufacturers' instructions and Contract Documents.

C. Manufacturers' Certificates:

1. When specified in individual specification Sections, submit manufacturers' certificates to Engineer, in quantities specified herein.
2. Indicate that a material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
3. Certificates may be recent or previous test results on material or Product, but must be acceptable to Engineer. If these are outdated and/or not acceptable to Engineer, the Contractor shall submit to the Engineer the new certificates and test results on materials or product.

D. Tests and Test Reports:

1. Classify each as either "project related" or Product Data, depending upon whether report is uniquely prepared for project or a standard publication of workmanship control testing at point of production, and process accordingly.
2. All test equipment used shall be verified to be in calibration at the time of each test and test reports shall so indicate. No test shall be made without such verification.

E. Standards:

1. Where copy submittal is indicated, and except where specified integrally with Product Data submittal, submit a single copy for Engineer's use.

2. Where workmanship at project site and elsewhere is governed by standards, furnish additional copies to fabricators, installers and others involved in performance of the work.

****END OF SECTION ****

# SECTION 01400
# QUALITY ASSURANCE AND QUALITY CONTROL

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. All goods, services, labor and equipment to facilitate proper construction of all appurtenant components of the landfill final cover system including the Final Cover System, collection ditches and channels, along with related work required by the Drawings and Specifications.

B. Inspection and documentation procedures that shall be utilized before, during, and after construction to provide assurance, with a reasonable degree of certainty, that the constructed facility meets the design standards and specifications. This program is to be administered by the Owner. Verification that the construction is in accordance with the design standards, Drawings and Specifications is the responsibility of the Group's designated representatives. The QA activities and QC testing procedures of the Engineer are specified in the "Construction Quality Assurance Plan."

### 1.02 RESPONSIBLE PARTIES AND LINES OF AUTHORITY

A. The Group is the Albion-Sheridan PRP Group.

B. The Project Coordinator is the official representative of the Albion-Sheridan PRP Group, and is in charge of administration of the work and the completion of the project.

C. The Engineer and QC Personnel report directly to the Project Coordinator and are responsible for:

1. Review and updating of project design Drawings and Specifications;

2. Quality assurance of the work;
3. Maintenance of pertinent construction documents;
4. Coordination of the Quality Assurance Observation/Testing;
5. Review of test data and observations;
6. Identification of work to be accepted or rejected;

D. Field closure QA/QC activities by the Engineer and QC Personnel will include:

1. Field testing and inspection of site grading and fill placement.
2. Field testing and inspection of concrete placement.
3. Inspection of drainage structures and vegetation.
4. Inspection of well and gas extraction system modifications.
5. Laboratory testing of soils for conformance to material specifications.
6. Oversight of the Contractor for compliance with the Contract Documents.
7. Daily reports of field activities.
8. Other forms of documentation including photographic records.

E. The Contractor is responsible for the successful completion of the contractual duties and requirements as it pertains to the work, supervision of the earthwork and his subcontractors and employees, and overall coordination and scheduling of the work. The Contractor shall carry out the Quality Assurance (QA) testing and Quality Control (QC) programs for parts of the work which are not performed by the Engineer and promptly supply a copy of the documentation of the QA and QC work to the Engineer.

## 1.03 PERSONNEL QUALIFICATIONS

A. Prior to commencement of the work, organizations responsible for any portion of the construction shall provide the Project Coordinator with the following information, as a minimum:

1. Professional capabilities;
   -summary of corporate capabilities,
   -summary of experience with similar projects, and
   -list of references.

2. Personnel;
-lines of authority for project personnel,
-personnel responsibilities, and
-resumes of personnel to be involved.

## 1.04 DOCUMENTATION

A. The Engineer and QC Personnel will coordinate and document Construction Quality Assurance activities associated with the Work. Such documentation shall be in compliance with that outlined in the "Construction Quality Assurance Plan" (CQAP).

B. The Contractor shall assist the Engineer by providing submittals required in the Specifications and on the Drawings, as-built survey information and other information specified herein or requested by the Engineer.

C. Daily records shall contain all data outlined in the CQAP and utilize the proper daily record form.

D. Periodic summary reports shall contain all items outlined in the CQAP.

E. The Engineer will prepare Drawings with updated revisions consistent with as-built conditions upon final completion of the Work.

F. The Contractor will provide as-built survey data to the Engineer in the specified format.

## 1.05 MEASUREMENT AND PAYMENT

A. No quantity measurement or separate payment will be made for the work performed by the Contractor for Construction Quality Assurance as described in this Section and elsewhere in these Specifications. Payment for CQA shall be included in the

Unit Prices and Lump Sums bid in the Bid Schedule for items requiring the QA/QC work.

## PART 2 PRODUCTS (not used)

## PART 3 EXECUTION (not used)

*** * END OF SECTION * ***

## SECTION 01450
## HEALTH AND SAFETY

## PART 1 GENERAL

### 1.01 REQUIREMENTS INCLUDE

A. The Contractor shall designate a Site Safety Officer (SSO) and provide a site-specific Site Safety Plan (SSP) for the remedial action activities at the site and provide the Plan to the Owner, Engineer, MDEQ and U.S. EPA prior to commencement of the Work. Review of the Health and Safety Plan will not constitute an endorsement or approval of the Plan and shall not relieve the Contractor of its Health and Safety responsibilities.

B. Section 1.02 (Landfill Considerations) and Section 1.03 (Environmental Considerations) summarize general conditions that can be expected at a closed landfill facility and hazardous waste site. For more specific information on site conditions and potential site hazards, the Contractor shall review documents specific to the Albion-Sheridan Township Landfill. The Contractor shall use site-specific data available in the aforementioned documents to design the site-specific Site Safety Plan (SSP). Documents available for review include:

- Unilateral Administrative Order, October, 1995, prepared by United States Environmental Protection Agency
- Remedial Investigation Report, April, 1994, Prepared by WW Engineering & Science
- Final Presumptive Remedy Feasibility Study, September, 1994, Prepared by WW Engineering & Science
- Technical Memorandum No. 1, June, 1994, Prepared by ABB Environmental Services
- Pre-Design Studies, October, 1996, Prepared by Woodward-Clyde Consultants

- Remedial Action Workplan, May, 1997, Prepared by Woodward-Clyde Consultants
- Final Design Workplan, May, 1997, Prepared by Woodward-Clyde Consultants

## 1.02 LANDFILL CONSIDERATIONS

A. The Contractor shall notify employees that the site is a hazardous waste site and shall require its employees to use appropriate protective devices and to observe safe working practices. No smoking will be allowed at the site.

B. Migration distance may be greater where gases pass through underground conduits or where surface conditions interfere with normal venting through soil cover. The following conditions may exist at a landfill:

- Fires may start spontaneously from exposed and/or decomposing refuse.
- Fires and explosions may occur from the presence of methane gas.
- Landfill gasses may cause an oxygen deficiency in underground trenches, vaults, conduits and structures.
- Hydrogen sulfide ($H_2S$), a highly toxic and flammable gas, and volatile organic compounds (VOCs) may also be present.
- Possible caving of trenches and excavations when working over or in waste disposal areas.

## 1.03 ENVIRONMENTAL CONSIDERATIONS

A. The following are environmental conditions which may exist at the site. These are given for the benefit of the Contractor and are not intended to be complete or to be the basis for the structuring of the Contractor's Health and Safety program and site-specific Site Safety Plan. The Contractor shall designate a Safety Officer at the site who shall have the responsibility of monitoring the Contractor's safety program and practice. The Engineer, Owner, or Project Coordinator by making the site conditions known to the Contractor, shall have no responsibility for site safety for persons or property, and the Contractor shall indemnify and hold Owner, Engineer and Project Coordinator harmless from any claims resulting from Contractor's failure to establish and follow good health and safety practices in accordance with all applicable codes, regulations and guidelines.

B. The environmental concerns are given in two categories which describe: (1) general conditions for working in the vicinity of landfill, and (2) considerations when working on waste filled areas.

C. General conditions include:

1. Methane, hydrogen sulfide or other gases may emanate from the natural decomposition of refuse buried at or near the job site.
2. A qualified person shall be designated as Site Safety Officer. It is the Contractor's responsibility to provide the Safety Officer. The Safety Officer or a qualified designee shall be present at all times with appropriate instruments to monitor as defined in the Site Safety Plan.
3. No welding shall be permitted in waste excavation or placement areas, trenches, enclosed areas or over other waste filled areas unless performed over ground mats or in areas of the site approved by the Site Safety Officer.
4. No excavation greater than 4 feet deep shall be left unattended or left open overnight unless securely covered in accordance with OSHA Regulations and in a manner acceptable to the Engineer. Precautions shall be taken to prevent open waste surfaces from the run-on of stormwater.
5. Fire extinguishers (10 lb. minimum capacity) shall be available with each Contractor vehicle on the site and be rated at least A, B and C.

D. Considerations in refuse filled areas include:

1. There is the potential of unstable soil and refuse material and the strong possibility of caving during waste excavation operations.
2. Hydrogen sulfide ($H_2S$), methane and other gasses may be present in excavations.
3. Construction and waste moving equipment shall be equipped with vertical exhaust and spark arresters.
4. Motors utilized in refuse excavation areas shall be explosion-proof.

5. Start-up and shutdown of equipment shall not be done in areas of exposed refuse.
6. Soil shall be stockpiled adjacent to operations in areas of exposed refuse for fire fighting purposes. The Contractor shall have a stockpile of soil relative in size to the expected size of the refuse excavated areas.
7. The use of explosives is not permitted.
8. Any waste exposed during waste relocation activities shall be covered with at least a 6-inch layer of earth or other suitable cover if it is not disturbed for longer than 24 hours or if required to reduce windblown waste.
9. Inhalation of landfill gases shall be avoided as much as possible. Such gases (or oxygen deficient air) may cause nausea and dizziness, which could lead to accidents.
10. Contractor shall not leave open waste excavations unattended.

11. The Contractor shall not, unless directed by the Engineer, excavate into the landfill waste in locations other than those shown on the Drawings. If for any reason landfill waste is exposed at locations other than those shown on the Drawings, the Contractor shall immediately notify the Engineer.
12. The Contractor shall provide excavation and waste moving equipment with provisions for attaching supplied air tanks and enclosed cabs for equipment involved in waste movement operations should switching to Level B respiratory protection become necessary.

## 1.04 HEALTH AND SAFETY PROGRAM (HSP)

A. A written health and safety program for employees and subcontractors engaged in hazardous waste operations shall be developed and implemented by the Contractor, as required by 29 CFR 1910.120(b). This written program shall be made available to the Owner upon request.

## 1.05 SITE-SPECIFIC SITE SAFETY PLAN (SSP)

A. The Contractor shall develop and implement a detailed updated site-specific Site Safety Plan (SSP) for the waste relocation activities in accordance with the provisions identified in 29 CFR 1910.120(b)(1). Contractor shall be responsible for the development, implementation and monitoring of the SSP. These specifications are intended only to provide general guidance and to identify minimum requirements for the SSP by all on-site personnel, including the Owner/Engineer and all subcontractors at all times during construction.

B. The Contractor shall submit within 10 calendar days of the Notice to Proceed for on-site work, five (5) copies of the site-specific Site Safety Plan (SSP) to the Owner. The plan will be reviewed by the Owner, Engineer, MDEQ and U.S. EPA. Review of the SSP by the Owner, Engineer and the respective agencies shall not constitute an endorsement or acceptance of the SSP and shall not relieve the Contractor of his safety responsibilities.

C. Contractor shall use the SSP to inform all On-Site Personnel and Visitors of safety and health hazards specific to the Site.

D. The Contractor shall provide a copy of the required SSP to the Engineer and Owner for record and review and shall post a copy of the Plan at the job site.

E. The Contractor shall conduct all activities performed as a part of this remedial action in accordance with the following published regulations:

1. 29 CFR Part 1926, Construction Industry Standards and 29 CFR Part 1910, General Industry Standards.
2. Department of Labor, Occupational Safety and Health Act (OSHA) of 1970 (PS-19-596) and under Section 107 of the Contract Work Hours and Safety Standards Act (PS-91-54).

F. Disregard for the provisions of this Section of these Specifications shall be deemed just and sufficient cause for termination of the Agreement without compromise or prejudice to the rights of the Owner.

G. The Owner reserves the right to shut down the waste relocation activities at no additional cost to the Owner if the Contractor does not perform the Work in accordance with the SSP.

H. The Contractor's SSP shall define hazardous substance concentration action levels which shall govern the performance of Work under Level B, Level C and Level D personnel protection as defined in 29 CFR 1910.120, Appendix B.

I. Determination of the appropriate level of worker safety equipment, action levels and procedures shall be made by the Contractor as a result of review of existing site-specific data, the initial site survey and continued safety and health monitoring performed by Contractor or his designated safety officer. The Contractor shall assess the following work activities, at a minimum, in detail as part of the SSP:

1. Field engineering and surveying,
2. Temporary construction facilities,
3. Waste excavation,
4. Waste transportation,
5. Decontamination,
6. Drum Removal,
7. Drum Sampling,
8. Drum Overpacking,
9. Drum Transportation,
10. Underground storage tank removal/disposal.
11. Landfill Gas Vent Trench Installation

J. The following is the minimum personal protective equipment (PPE) required under each level:

1. Level B:

   a. Pressure demand full-facepiece self-contained breathing apparatus (SCBA), or pressure demand supplied air respirator with escape SCBA (NIOSH approved).
   b. Hooded chemical-resistant clothing (overalls and long-sleeved jacket; coveralls; one or two-piece chemical-splash suit; disposable chemical-resistant overalls), sealed to gloves and boots.
   c. Coveralls.
   d. Gloves, outer, chemical-resistant.
   e. Gloves, inner, chemical-resistant.
   f. Boots, outer, chemical-resistant steel toe and shank. Boot-covers, outer, chemical-resistant (disposable).
   g. Hard hat.
   h. Face shield.

2. Level C:

   a. Full-face air purifying respirators with proper cartridges (NIOSH approved).
   b. Hooded chemical-resistant clothing (overall, two-piece chemical splash suit; disposable chemical-resistant overalls).
   c. Coveralls.
   d. Gloves, outer, chemical-resistant.
   e. Gloves, inner, chemical-resistant.
   f. Boots (outer), chemical-resistant steel toe and shank. Boot-covers, outer, chemical-resistant (disposable).
   g. Hard hat.
   h. Face shield.

3. Level D:

a. Coveralls.
b. Gloves.
c. Boots/shoes, chemical-resistant steel toe and shank.
d. Boots, outer, chemical-resistant (disposable).
e. Safety glasses or chemical splash goggles.
f. Hard hat.

## 1.06 SITE CONTROL

A. Contractor shall inform his On-Site Personnel and Visitors of any hazardous substances, health hazards, confined spaces or any other risks that they may be exposed to, prior to commencement of the Work.

B. Contractor shall include in his SSP, a Site control program as required by 29 CFR 1910.120(b)(3).

C. Contractor shall limit equipment, operations and On-Site Personnel and Visitors in accordance with the following work areas:

1. Exclusion Zone: All On-Site Personnel and Visitors entering the Exclusion Zone shall wear the prescribed level of personal protective equipment and shall be trained as prescribed in Section 1.8.
2. Contamination Reduction Zone: This area will provide for the decontamination of waste transport vehicles prior to entering the Support Zone, the decontamination of On-Site Personnel and Visitors and clothing prior to entering the Support Zone, and for the physical segregation of the Exclusion and Support Zones.
3. Support Zone: Throughout the waste relocation activities, the Support Zone shall be secured against active or passive contamination from the Work. The function of the Support Zone includes:

a. an entry area for On-Site Personnel, visitors, and equipment to the Exclusion Zone through the Contamination Reduction Zone of Site operations;

b. an exit area for decontaminated On-Site Personnel and Visitors, materials and equipment from the Exclusion Zone of Site operations through the Contamination Reduction Zone,

c. a storage area for clean safety and work equipment; and

d. parking.

D. The work zone divisions are not required if the Contractor can show that his operations do not involve employee exposure or reasonable possibility for exposure as defined by applicable provisions of 29 CFR 1910.120. The Contractor shall apply for such variance to OSHA's enforcement division. Under no circumstance shall Contractor be exempt from the general industry health and safety requirements of 29 CFR 1910.

## 1.07 SECURITY

A. Restrict vehicular access to the Exclusion and Contamination Reduction Zones of the Site to authorized vehicles only.

B. Do not permit personal vehicles to enter the Site, except in designated parking areas within the Support Zone.

C. Maintain a log of security incidents.

D. Require all On-Site Personnel and Visitors having access to the Site to sign in and sign out, and keep a record of all Site access.

E. Brief all approved Visitors to the Site on safety and security, provide them with temporary identification and safety equipment, and escort them throughout their visit.

## 1.08 TRAINING

A. The Contractor shall provide copies of training certificates prior to commencement of work to the Engineer for each employee working on the site that documents that they have received training in accordance with 29 CFR 1910.120.

B. The Contractor shall not permit On-Site Personnel and Visitors who have not successfully completed the required training to enter the Exclusion Zone/Contamination Reduction Zone of the Site.

## 1.09 SANITATION

A. The Contractor shall provide sanitation and hygiene facilities as specified in 29 CFR 1910.210(n). Due to the biological hazards expected, showers shall be provided for field personnel during all waste consolidation work.

## 1.10 MEDICAL SURVEILLANCE

A. The Contractor shall maintain all medical surveillance records of Contractor and Subcontractor Personnel and make records available to the Owner or regulatory agencies upon request. Records shall be maintained for the period specified and to meet the criteria of 29 CFR 1910.120(f).

## 1.11 MONITORING

A. The Contractor shall implement an air monitoring program sufficient to characterize and quantify employee exposure to airborne levels of Hazardous Substances as identified in review of the site-specific data in order to determine the appropriate level of employee protection needed on a real-time basis at the Site and otherwise comply with the requirements of 29 CFR 1910.120(h).

B. The Contractor shall conduct air monitoring and sampling for gases, vapors, and particulates. The Contractor shall report any departures from general background to the Group and Engineer. The monitoring results shall be compared to Action Levels established in the SSP.

C. The Contractor shall provide, calibrate and maintain in operating condition all monitoring instruments. The Contractor shall maintain records of instrument calibrations, calibration conditions, and maintenance.

D. Monitoring equipment shall be provided and operated by Contractor Personnel trained in the use of the specific equipment provided.

E. The Contractor shall maintain a log of the location, time, type, and value of each reading and/or sampling. Provide copies of daily log sheets and calibration records to the Owner for review of the data.

F. The Contractor shall monitor for the following compounds during the waste relocation program.

Methane

Methane is a flammable/explosive gas. A lower explosive limit and oxygen ($LEL/O_2$) meter will be used with appropriate action levels to protect workers. $LEL/O_2$ instruments will be placed in strategic work locations, with alarms set to notify workers when a pre-set action level is reached. The contractor will be expected to continuously monitor areas where waste is hauled for LEL. Exceedance of LEL action levels will result in stopping work and controlling the source of the methane.

Techniques for controlling the source such as covering and ventilation will be detailed by the Contractor.

Volatile Organic Compounds

Volatile organic compounds (VOCs) have been identified in the landfill gas at Albion-Sheridan Township Landfill.

The Contractor must monitor for these compounds on a real-time basis during all phases of the waste relocation activities. Monitoring can be accomplished with instrumentation equipped with a photoionization detector (PID). This instrument is not compound specific; therefore, specific evaluations for individual VOCs can be accomplished with compound specific detector tubes or integrated air sampling and laboratory analysis. The work area breathing zones must be evaluated at least every two hours and more often if action levels are exceeded. If action levels are exceeded, the Contractor is to assure the monitoring frequency measures in place are protecting the workers.

When action levels are exceeded, the Contractor will immediately take measures to protect the workers, and if possible, reduce vapor levels below action levels. The Contractor is expected to describe techniques for reducing vapor levels while performing the relocation of the landfill tasks.

Any exceedances to the action level will be reported to the Owner's site safety manager immediately (within one hour). All monitoring data will be documented in the air monitoring log book maintained by the Contractor. This book will also contain the daily calibration and other pertinent history for the instrument used on the site.

Particulates

General dust control measures must be in place and described by the Contractor. Visible dust and general dust above 5.0 mg/m$^3$ must be controlled. The Contractor is expected to monitor and observe the atmosphere around the Contractor's activities for visible dust and monitor using real times instrumentation to reduce dust below 5.0 mg/m$^3$.

## 1.12 DECONTAMINATION

A. The Contractor shall develop Decontamination Procedures for vehicles, equipment and personnel, properly communicate the procedures to all on-site personnel and ensure they are implemented before entering areas on Site where potential for exposure to Hazardous Substances exists. Procedures shall comply with the requirements of 29 CFR 1910.120(k).

B. The Contractor shall decontaminate all vehicles and equipment used in the Exclusion Zone. The Contractor shall decontaminate all vehicles and equipment used in the relocation of solid waste. Decontamination shall be performed in the Contamination Reduction Zone prior to leaving the Site.

C. Decontamination of excavation and waste moving equipment utilized at the Site shall include, but not be limited to, the following procedures:

1. Physical removal of solid materials.
2. Complete steam cleaning.
3. Complete detergent rinse.
4. Final steam rinse.

D. Wash water will be controlled so that it does not percolate into the underlying soils. A membrane or compacted soil lined decontamination basin will be constructed on-site and all wash water and solids collected from the decontamination process collected. Disposal of the collected liquids and solids shall be to properly permitted facilities approved by the Engineer. Contractor shall submit disposal receipts from the respective facilities indicating the date and quantity disposed to the Engineer.

## 1.13 EMERGENCY RESPONSE

A. The Contractor shall develop an Emergency Response Plan (to be included in the SSP) to handle potential on-site emergencies conforming to the requirements of 29 CFR 1910.120(1).

B. The Contractor shall develop and include a Contingency Plan in the SSP. At a minimum, this plan shall describe:

1. Name of the person or entity responsible for responding in the event of an emergency incident.

2. Plan and date(s) for meeting(s) with the local community, including local, state and federal agencies involved in the cleanup, as well as local emergency squads and hospitals.
3. First aid medical information.
4. Air Monitoring Plan (if applicable).
5. Spill Prevention, Control, and Control Measures (SPCC) Plan (if applicable), as specified in 40 CFR Part 109 describing measures to prevent and contingency plans for potential spills and discharges from materials handling and transportation.

C. The Contractor shall confer with the Owner, local police, civic leaders, and hospital and ambulance staffs to explain the specific work activities that will be performed at the Site and establish emergency procedures.

D. The Contractor shall report both by telephone and in writing to the Engineer, Owner and appropriate authorities all accidents whatsoever arising out of, or in connection with, the performance of the Work, whether on or adjacent to the Site, which caused death, personal injury or property damage, giving full details and statements of witnesses.

E. The Contractor shall provide at least one "industrial" first-aid kit and stretcher, fully stocked, located in an easily accessible and uncontaminated location.

F. If hazardous wastes are encountered during waste excavation activities, appropriate additional safety decisions shall be made by the Contractor, a specially trained crew shall be used, and the area cordoned off as an exclusion zone. Under this unusual circumstance, all activities shall conform with specific OSHA requirements.

## 1.14 OTHER REQUIREMENTS

A. Contractor shall comply with other requirements as applicable in 29 CFR 1910, including but not limited to:

1. Permit Required Confined Spaces - 29 CFR 1910.146

2. Hazard Communication Standard - 29 CFR 1910.1200
3. Control of Hazardous Energy (Lockout/Tagout) - 29 CFR 1910.147
4. Employee Emergency Plans & Fire Protection Plans - 29 CFR 1910.38
5. Key Personnel - 29 CFR 1910.120 (i)(2)(i)
6. Safety and Health Risks - 29 CFR 1910.120 (i)(2)(i)
7. Training - 20 CFR 1910.120 (i)(2)(i)
8. Medical Surveillance - 29 CFR 1910.120 (i)(2)(i)
9. Confined Space Procedures - 29 CFR 1910.120 (i)(2)(i)
10. Air Monitoring - 20 CFR 1910.120 (i)(2)(i)
11. Decontamination - 29 CFR 1910.120 (i)(2)(i)
12. Contingencies - 29 CFR 1910.120 (i)(2)(i)
13. Respiratory Protection - 29 CFR 1910.134

## 1.15 MEASUREMENT AND PAYMENT

A. No quantity measurement will be made for the Work performed for Health and Safety as described in this Section. Payment for Health and Safety will be at the Lump Sum price bid in the Bid Schedule.

## PART 2 PRODUCTS (not used)

## PART 3 EXECUTION (not used)

****END OF SECTION****

# SECTION 02110
# CLEARING, STRIPPING AND GRUBBING

## 1.0 GENERAL

### 1.01 SECTION INCLUDES

A. Clearing, stripping and grubbing of all vegetation, roots and topsoil from the work area.

B. Protection and preservation of trees and vegetation outside the clearing limits.

C. Disposal off site of all debris, stumps, roots, and other objectionable material.

### 1.02 RELATED SECTIONS

A. Section 02115 - Site Preparation

B. Section 02220 - Earthwork

### 1.03 REGULATORY REQUIREMENTS

A. Disposal shall be performed in accordance with all applicable laws and regulations. The Contractor shall be responsible for identification and compliance of these laws and specifications. All permits retained to complete the Work shall be copied and submitted as required by Section 01500, Submittals.

B. On-site disposal of materials shall be performed in accordance with all applicable laws, regulations, at areas designated on the Plans and as approved by the Engineer.

C. At all times, comply with federal, state, and local regulations in force to prevent pollution of air and water.

D. Perform all site clearing activities in accordance with the Site Safety Plan (SSP) and under the supervision of the Site Safety and Health Officer (SSHO).

## 1.04 MEASUREMENT AND PAYMENT

A. For items of work for which specific Unit Prices or Lump Sum prices are established in the contract, payment for such items will be made at the Unit Prices or Lump Sum prices bid in the Bid Schedule for the corresponding item. Such payment will constitute full compensation for all labor, equipment, materials, and all other items necessary and incidental to the completion of the Work.

B. Compensation for any item of work described in the Contract but not listed in the Bid Schedule will be included in the payment for the item of work to which it is made subsidiary.

# PART 2 PRODUCTS (NOT USED)

# PART 3 EXECUTION

## 3.01 CLEARING

A. Clearing shall include the removal from the site of all vegetation, including, but not limited to, weed growth, brush, shrubs, trees, roots, and boulders within the construction areas indicated on the Plans.

## 3.02 GRUBBING

A. Grubbing shall include the removal and disposal of wood or root matter below the ground surface remaining after clearing and shall include roots, trunks, and stumps greater than 2 inches in diameter to a depth of 6 inches below ground surface.

## 3.03 DISPOSAL OF DEBRIS

A. Unless otherwise specified, all materials removed from the cleared and grubbed areas shall be buried at on-site locations approved by the Engineer or otherwise disposed of as approved by the Owner.

B. Trees, roots and stumps larger than 3 inches in diameter shall be processed through a shredding or chipping device prior to burying at the designated on-site locations.

## 3.04 STRIPPING

A. Stripping shall include the removal and stockpiling of all organic sod, topsoil, roots and other material remaining after clearing. The depth of cut required shall be a minimum of 3 inches or as otherwise directed by the Engineer. Stripped materials will be transported to a designated on-site area(s) as approved by the Engineer. Materials from on-site excavations shall not be hauled off site without approval from the Engineer.

B. Vegetation root mat shall be removed in segments to limit exposure for potential soil sloughing and slope stability. Utilize procedures for root mat removal and backfill placement which will not cause slope instability. Soil sloughing or instability of cleared areas of slope shall be immediately repaired by the Contractor at no additional cost to the Owner.

C. All necessary precautions shall be taken by the Contractor to preserve the materials below and beyond the lines of all excavation in the soundest possible condition. Any and all excavations made below and beyond the lines of excavation by the Contractor for any purpose or reason, except as may be otherwise specified or directed by the Engineer, shall be at the expense of the Contractor, and all such excess and other excavation shall be refilled, where required to complete the work, by the Contractor with buffer fill materials, unless other materials are required by the Engineer, furnished and placed at the expense of the Contractor.

D. No additional allowance will be made on account of excavated materials being wet or frozen or requiring ripping for removal.

****END OF SECTION -****

**SECTION 02211**

**WASTE CONSOLIDATION AND HANDLING**

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Excavation of waste materials.

B. Movement and placement of waste materials

### 1.02 RELATED SECTIONS

A. Section 01450 - Health and Safety

B. Section 02215 - Site Preparation

C. Section 02220 - Earthwork

### 1.03 DESCRIPTION OF THE WORK

A. Approximately fifty thousand (50,000) cubic yards of waste materials shall be moved from the eastern fill area to the main fill area. Specific areas of waste excavation and placement are shown on the Drawings

B. The waste excavation, movement and placement shall occur during a single 10-day period.

C. Salvage and stockpile intermediate cover materials in areas shown on the Drawings.

D. The waste consolidation activities shall be completed prior to commencing construction of the landfill cover system. This includes grading of the consolidated waste material to proper fill contours as shown on the Drawings.

## 1.04 HEALTH AND SAFETY CONSIDERATIONS

A. All necessary precautions shall be taken to protect workers from exposure to waste.

B. Contractor shall perform all handling of waste materials in accordance with the Site Safety Plan.

C. Contractor shall perform on-site air monitoring during the waste consolidation. Refer to Section 1450 - Health and Safety for specific requirements.

## 1.05 MEASUREMENT AND PAYMENT

A. Measurement for Waste Excavation and Handling shall be by surveying the volume of waste excavated approximately to the nearest cubic yard by use of the average end method. Survey cross sections shall be surveyed by the Contractor at a minimum of 50 foot centers over the area of waste consolidation and at any significant grade changes within this area. The surface of the waste consolidation area shall be surveyed as described after removal of existing cover materials to the top of waste in an area.

B. Payment for Waste Excavation and Handling will be the volume of Waste Excavation as described in the Unit Quantity bid in the Bid Schedule. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work.

# PART 2 PRODUCTS - NOT USED

## PART 3 EXECUTION

### 3.01 WASTE EXCAVATION

A. After excavating and salvaging intermediate cover materials, waste materials shall be excavated from the area located along the eastern perimeter of the landfill as shown on the Drawings. The waste excavation and handling work shall occur during a single 10-day period in conjunction with clearing, stripping and grubbing, rough grading and shaping process of the cover soil layer placement.

B. Waste shall be excavated in narrow strips to minimize the area of waste exposed at any one time. The open excavation area shall not exceed 100 feet by 300 feet at any given time.

C. At the end of each day's operations, all exposed waste shall be covered. The preferred method of covering the waste is with a six (6) inch layer of cover soils. Other methods of providing a daily cover shall not be used without written approval of the Engineer.

D. Excavations shall be properly sloped and marked as required to prevent cave-in or loose material from falling into excavations.

E. All necessary precautions shall be taken to preserve the material beyond the lines of excavations.

F. Surface run-on shall be directed away from open excavations by the use of constructed berms along the top of the slopes.

G. Erosion products shall be prevented from leaving the limits of the work. Materials eroded off-site shall be collected and returned to the site.

## 3.02 WASTE MOVEMENT AND PLACEMENT

A. Excavated waste materials shall be placed in areas indicated on the Drawings or as directed by the Engineer.

B. Grades indicated on the Drawings are final grades. Waste shall be placed to gradesthree (3) feet below final grades in areas of final cover system construction.

C. Waste shall be placed in uniform lifts no greater than four (4) feet thick and compacted with a minimum of three (3) passes of a compactor similar to a Caterpillar Model 815 or equal approved by the Engineer.

## 3.03 COORDINATION WITH OTHER ACTIVITIES

A. Contractor shall coordinate waste consolidation activities with placement of the gas collection/foundationlayer soils.

B. Contractor shall coordinate waste consolidation activities with other parties who will be conducting on-site air monitoring activities in compliance with Section 1450 - Health and Safety.

****END OF SECTION ****

# SECTION 02212
# DRUM REMOVAL AND DISPOSAL

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Excavation of waste drums.

B. Field sampling and laboratory testing of wastes contained in removed drums.

C. Overpacking and disposal of characterized wastes and drums.

### 1.02 RELATED SECTIONS

A. Section 01450 - Health and Safety

B. Section 02215 - Site Preparation

C. Section 02220 - Earthwork

D. Appendix C - Drum Management Plan (Volume 2)

### 1.03 DESCRIPTION OF THE WORK

A. Approximately 200 to 400 drums of waste shall be removed from the area noted as "Drum Excavation and Removal Area" on the Drawings.

B. The drum excavation, removal and sampling shall take place in a single 10 working-day period.

C. Salvage and stockpile intermediate cover materials in areas shown on the Drawings.

D. The drum removal activities shall be completed prior to commencing construction of the landfill cover system.

E. A temporary drum staging area shall be established for the period between removal and disposal of the drums as shown in the drawings. See Section 3.2 for the staging area requirements.

## 1.04 HEALTH AND SAFETY CONSIDERATIONS

A. All necessary precautions shall be taken to protect workers from exposure to waste.

B. Contractor shall perform all handling of waste materials in accordance with their Site Specific Health and Safety Plan and all applicable local, state and federal regulations.

C. Contractor shall perform on-site air monitoring during the drum excavation and removal. Refer to Section 1450 - Health and Safety for specific requirements.

## 1.05 MEASUREMENT AND PAYMENT

A. Measurement for drum excavation, removal, sampling, testing, overpacking, transportation and disposal shall be as described in the Unit Quantity bid in the Bid Schedule. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work.

## 1.06 SUBMITTALS

A. Pre-Construction Submittals:

1. Shall conform with the requirements of Section 01300 - Submittals.
2. Submit qualifications and experience of any subcontractors associated with the work outlined in this section.

3. Submit name and location of the testing laboratory to be utilized for TCLP analysis.
4. Submit facility name and location of the disposal facility (s) to be utilized for drum disposal.

B. Contractor shall submit a documentation report detailing drum removal, sampling and disposal.

## PART 2 PRODUCTS - NOT USED

## PART 3 EXECUTION

### 3.01 DRUM EXCAVATION AND OVERPACKING

A. Prior to commencing excavation activities in the drum removal area, the Contractor shall establish necessary on-site safety zones in compliance with the Health and Safety Plan as well as a staging area for excavated drums prior to disposal as shown on the Drawings.

B. After excavation and salvaging of intermediate cover materials, drums shall be excavated from the drum excavation and removal area located on the eastern portion of the landfill as shown on the Drawings. The drum excavation and handling work shall occur during a single 10 working-day period prior to waste consolidation activities.

C. Excavation into soils within the delineated drum removal area shall be done with a backhoe using a smooth cutting edge on the bucket proceeding downward in 6-12 inch lifts.

D. Excavations shall be properly sloped and marked as required to prevent cave-in or loose material from falling into excavations. Drum Removal excavation(s) shall be covered with 6-mil plastic following completion of each days work. The excavation(s) covering will be maintained until the excavation(s) is backfilled.

E. All necessary precautions shall be taken to preserve the integrity of the excavated drums to reduce the amount of overpacking required. All drums that do not have adequate structural integrity and contain wastes shall be overpacked in containers approved by the U.S. DOT and Engineer.

F. Surface run-on shall be directed away from the open excavation by the use of constructed berms along the top of the slopes.

## 3.02 DRUM STORAGE, SAMPLING, TESTING AND DISPOSAL

A. Excavated drums shall be removed from the excavation and placed on a temporary storage pad on-site. Overpacked drums from previous test pit excavations located adjacent to the drum excavation and removal area shall also be incorporated onto the temporary storage pad for inclusion into the sampling, testing and disposal process. This pad shall have a 40 mil HDPE liner placed over the ground surface and be constructed as indicated in the Drum Management Plan (Appendix C - Volume 2). The liner will be anchored outside the toe of berm to prevent shifting of the protective barrier during sampling and transportation activities. Configuration of the temporary storage pad shall be approved by the Engineer prior to placement of excavated drums.

B. Sampling of drummed waste shall be in accordance with the Drum Management Plan approved by the EPA and the Engineer.

C. Testing of the collected samples shall be performed in accordance with the approved Drum Management Plan.

D. Results of the testing and proposed disposal site and method shall be provided to the Engineer for approval. Drums not containing any waste or solid waste that is below the action levels as determined by the U.S. EPA and MDEQ shall be incorporated under the landfill cap area.

E. Transportation of all hazardous materials from the site shall comply with all local, state and federal regulations and be performed by a properly licensed party.

F. Disposal of drums containing liquids and hazardous materials as determined by the testing results shall be disposed of at an off-site facility(s) that are in compliance with U.S. EPA's Off-Site Rule.

G. Any liquid generated on top of the HDPE liner during the temporary storage of the drums must be sampled and tested in accordance with RCRA characterization methods and disposed of at an on-site location approved by the Engineer or at a permitted off-site facility. The on-site disposal option will be based on the results of the analytical testing and the land disposal restrictions in the state of Michigan. In the event on-site disposal is not restricted, the Contractor shall transport the accumulated water along with approximately 3,000 gallons of development/decontamination water temporarily stored on-site to a location to be determined by the Engineer and allowed to infiltrate. In the event on-site disposal is restricted, the Contractor shall transfer the accumulated water to an approved off-site disposal facility. Any off-site facility selected for disposal shall be in compliance with U.S. EPA's Off-Site Rule.

****END OF SECTION ****

# SECTION 02215
# SITE PREPARATION

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Removal, salvage and disposal of structures in the work area.

B. Protection of existing facilities.

C. Protection of utility lines.

### 1.02 RELATED SECTIONS

A. Section 02220 - Earthwork

B. Section 02110 - Clearing, Stripping and Grubbing

### 1.03 REGULATORY REQUIREMENTS

A. Disposal shall be performed in accordance with all applicable laws and regulations. The Contractor shall be responsible for identification and compliance of these laws and regulations. All permits retained to complete the work shall be copied and submitted as required by Section 01300, Submittals.

B. On-site disposal of materials shall be performed in accordance with all applicable laws, regulations, at areas designated on the Plans and as approved by the Engineer.

C. At all times, comply with federal, state, and local regulations in force to prevent pollution of air and water.

D. Perform all site clearing activities in accordance with the SSP.

## 1.04 MEASUREMENT AND PAYMENT

A. For items of work for which specific Unit Prices or Lump Sum prices are established in the contract, payment for such items will be made at the Unit Prices or Lump Sum prices bid in the Bid Schedule for the corresponding item. Such payment will constitute full compensation for all labor, equipment, materials, and all other items necessary and incidental to the completion of the Work.

B. Compensation for any item of work described in the Contract but not listed in the Bid Schedule will be included in the payment for the item of work to which it is made subsidiary.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

## 3.01 STRUCTURE REMOVAL

A. The work shall consist of the removal, salvage, or disposal of structures from the work areas. This shall include removal of underground storage tanks and residential structures on the site which will be affected by the work.

B. Removed tanks and structures shall be disposed of at the proper facilities or be recycled if deemed appropriate by the Engineer.

C. Unless otherwise specified, refuse materials resulting from structure removal shall be buried at locations approved by the Engineer or otherwise disposed of as specified or as approved by the Engineer.

## 3.02 PROTECTION OF EXISTING FACILITIES

A. The existing facilities on the site, shall be protected by the Contractor. The Contractor shall place markers and barriers as necessary or otherwise clearly designate existing facilities to be protected prior to the start of construction activities on the site. Any facilities damaged or destroyed by the Contractor shall be repaired or replaced at the expense of the Contractor.

B. The existing groundwater monitoring wells, protective posts and concrete pads shall not be disturbed and clearly marked during the entire duration of the work. Any repairs necessary as a result of the work shall be done at the expense of the Contractor.

C. Survey benchmark monuments to establish grade and location control have been established by previous parties; however, the survey information shall be verified by the Contractor.

## 3.03 UTILITY LINES

A. If active utility lines are encountered and are not shown on these plans or otherwise made known to the Contractor, the Engineer shall be immediately notified and Contractor shall promptly take the necessary steps to ensure that service shall not be interrupted. Call 1-800-MISSDIG prior to excavation.

*** * END OF SECTION * ***

# SECTION 02220
# EARTHWORK

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Excavation of common material.

B. Excavation of waste material.

C. Construction of the Landfill Cover System, includes placement of soil materials associated with: Gas Collection/Foundation Layer, Cover Soil Layer and Topsoil.

D. Construction of Stormwater Control Berms.

E. Construction of Access Road.

### 1.02 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

A. Filter Fabric - Section 02235

B. HDPE Pipe - Section 02715

### 1.03 RELATED SECTIONS

A. Section 02110 - Clearing, Stripping and Grubbing

B. Section 02215 - Site Preparation

C. Geomembrane - Section 02778

D. Drainage Net - Section 02240

## 1.04 REFERENCES

| | | |
|---|---|---|
| A. | ASTM C 88 - | Test Method for Material Soundness |
| B. | ASTM C 117- | Materials Finer than No. 200 (0.075 mm) Sieve by Washing |
| C. | ASTM C 136 - | Method for Sieve Analysis of Fine and Coarse Aggregates. |
| D. | ASTM D 422 - | Method for Particle-Size Analysis of Soils. |
| E. | ASTM D 698 - | Moisture Density Relations of Soils and Soil-Aggregate Mixtures Using a 5.5 Pound (2.49 kg) hammer and a 12-inch (304.8 mm) drop. |
| F. | ASTM D 1556 - | Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method. |
| G. | ASTM D 2434 - | Test Method for Permeability of Granular Soils. |
| H. | ASTM D 2922 - | Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth). |
| I. | ASTM D 2937 - | Test Method for Density of Soil in Place by the Drive Cylinder Method. |
| J. | ASTM D 3017 - | Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth). |

K. ASTM D 4253 - Test Method for Maximum Index Density of Soils Using Vibratory Table.

L. ASTM D 4254 - Test Method for Minimum Index Density of Soil and Calculation of Relative Density.

## 1.05 DEFINITIONS

A. Waste Materials: Materials classified as waste materials are the refuse materials presently in the landfill. These materials are composed of industrial/commercial and residential solid wastes.

B. Borrow: Material excavated on the site or taken from off-site borrow areas designated by the Engineer.

C. Well-Graded: A mixture of particle sizes that has no specific concentration, or lack thereof, of one or more sizes.

D. Layer: A compacted stratum without construction joints composed of several lifts of fill material.

E. Lift: A constructed segment of a layer composed of fill material placed in loose thicknesses and compacted as specified.

F. Joint: The interconnecting face between adjacent fill material layers constructed at different times.

G. Material Quality Evaluation Testing; Quality control testing performed to determine the suitability of a material for its intended use.

H. Construction Quality Evaluation Testing: Quality control testing performed to assure installation of a material in accordance with the construction standards and specifications.

## 1.06 SUBMITTALS

A. Pre-Construction Submittals:

1. Shall conform with the requirements of Section 01300 - Submittals.
2. Submit testing procedures and methods required for each type of material and segment of construction to the Engineer prior to starting the work.
3. Submit listing of equipment and methods to be used for fill and compaction to the Engineer for written acceptance prior to starting the work.

B. Construction Submittals:

1. Shall conform with the requirements of Section 01300 - Submittals.
2. Submit notification of intent to sample sources for imported materials to the Engineer and QC Personnel.
3. Submit certification, test results, source identification, and samples for imported material to the Engineer and QC Personnel.
4. Surveys of as-built conditions are the responsibility of the Contractor and shall be conducted by the Surveyor for components of the cover system, and surveyed cross sections shall be supplied to the Engineer.

C. Post-Construction Submittals:

1. Shall conform with the requirements of Section 01300 - Submittals.

D. Quality Control Submittals:

1. Shall conform with the requirements of Section 01300 - Submittals.
2. Submit certification, physical property, test results, background chemical test results, source identification, and samples for products and imported material.

## 1.07 QUALITY CONTROL

A. Contractor shall give advance notice of at least 24 hours to the Engineer and QA Officer when ready for compaction or subgrade testing and inspection.

B. Preconstruction material quality evaluations shall be performed by the Contractor. The Engineer and QA Officer shall be provided the opportunity to review all of the Contractor's preconstruction test results prior to incorporation in the respective cover system components fill. Testing type and frequency for preconstruction material quality evaluation are presented in Article 3.08.

## 1.08 QUALITY ASSURANCE

A. Construction Quality Assurance (CQA) monitoring shall be the responsibility of the QC Personnel and performed in accordance with the approved CQA Plan and Quality Control of this specification Section.

## 1.09 MEASUREMENT AND PAYMENT

A. The surface area for Gas Collection/Foundation Layer Placement, Cover Soil Placement and Topsoil Placement will be measured and computed to the nearest square foot. Area subject for payment shall be verified by survey on 50 foot centers.

B. Payment for Gas Collection/Foundation Layer Placement, Cover Soil Layer Placement and Topsoil Placement will be made at the Unit Prices bid in the Bid Schedule for each type of fill, complete in place. Except as otherwise specified herein, such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work. Fill taken from stockpiles or on-site borrow sources will be paid at the unit price for material placement.

C. Compensation for any item of work described in the Contract but not listed in the Bid Schedule will be included in the payment for the item of Work to which it is made subsidiary.

## PART 2 PRODUCTS

### 2.01 MATERIALS

A. Gas Collection/Foundation Layer Soils - Materials classified as Gas Collection/Foundation Layer soils are granular sand. This material shall be relatively free of organics, trash, particles greater than the screen size of a Number 4 Standard Sieve, or other deleterious matter. If required, material shall be processed such that it does not contain particles greater than the least dimension. Not more than 12 percent, by weight, shall pass through a number 200 standard sieve.

B. Type 1 Drain Layer Material

1. Drain Layer and filter aggregates shall be sand, gravel, or crushed stone or mixtures thereof. They shall be composed of clean, hard, durable mineral particles free from organic matter, clay balls, soft particles, or other substances that would interfere with their free-draining properties. Not more than 15 percent, by weight, shall be flat, elongated particles.
2. Aggregates of crushed limestone shall be used only if other suitable drain materials are not available in the opinion of the Engineer. Aggregates of crushed limestone shall be thoroughly washed and screened. Coarse aggregates containing crushed limestone shall have not more than 3 percent, by weight, of particles finer than the No. 4 sieve. Crushed limestone shall not be used for fine aggregates except in combination with other materials such that not more than 5 percent of the portion finer than the No. 4 sieve shall be crushed limestone.
3. Aggregates in Type 1 Drain Layer material shall be tested for soundness according to ASTM Method C 88, and shall have a weighted average loss

in five cycles of not more than 12 percent when sodium sulfate is used or 18 percent when magnesium sulfate is used.

4. Type 1 Drain Layer materials shall meet the following gradation requirements.

| Standard Sieve Size | Percent Passing by Weight |
|---|---|
| 1" | 100 |
| 3/4" | 90-100 |
| 3/8" | 20-55 |
| #4 | 0-10 |
| #8 | 0-5 |

5. Type 1 Drain Layer materials shall be stored and handled by methods that prevent segregation of particle sizes or contamination by mixing with other materials.

C. Road Surface Course

1. Gradation criteria for the aggregate surface materials shall conform to the gradation requirements as outlined below:

| Standard Sieve Size | Percent Passing by Weight |
|---|---|
| 1" | 100 |
| 3/4" | 90-100 |
| 3/8" | 50-90 |
| #4 | 35-70 |
| #40 | 10-35 |
| #200 | 3-10 |

2. At the time it is deposited on the roadbed, aggregate surface material shall be clean and free from organic material or other deleterious substances, and shall be of such nature that it can be compacted readily under watering and rolling to form a firm, stable base.

D. Washed Stone

1. Gradation Criteria for the Washed Stone aggregate to be utilized in the Passive Landfill Gas Horizontal Trenches shall conform to the gradation requirements as outlined below:

| Standard Sieve Size | Percent Passing by Weight |
|---|---|
| 1 ½" | 94-100 |
| 1" | 15-65 |
| ½" | 0-10 |
| #4 | 0-6 |

2. Washed Stone aggregate shall be stored and handled by methods that prevent segregation of particle sizes or contamination by mixing with other materials.

## 2.02 STORMWATER CULVERTS

A. The storm culverts shall be a 18-inch diameter reinforced concrete pipe (RCP) and shall conform to the requirements for circular RCP described in AASHTO M 170. Culvert lengths shall be determined from the Drawings.

B. Culvert outlets shall have flared concrete aprons.

C. The inlet structure shall be flared concrete apron or drop inlet structure as specified on the Drawings. Drop inlet structures shall have metal drainage castings that confirm to the requirements described in AASHTO M 105.

## 2.03 COMPACTION EQUIPMENT

A. Equipment used for proof rolling the top surface of the last lift of Gas Collection/Foundation Layer fill shall consist of a single drum smooth roller with drum drive, such as the Caterpillar model CS-553, the Hyster model C850A, or equivalent, as approved by the Engineer.

## 2.04 MOISTURE CONTROL EQUIPMENT

A. Water application equipment shall be equipped with a distributor bar or other device to assure uniform application.

# PART 3 EXECUTION

## 3.01 GENERAL

The paragraphs of this article apply to all fill materials and earthwork operations.

A. Verify that site clearing, grubbing, and stripping work have been completed in accordance with Section 02110 prior to beginning earthwork.

B. Verify that the survey control system is installed and properly protected from construction operations prior to earthwork.

C. Verify that areas to be filled are free of roots, stumps, debris, ice, or water, and ground surfaces are not frozen.

D. Place fill material layers only <u>after</u> the previous layer has been accepted by the QC Personnel. Any damage to the previous layer or deterioration subsequent to acceptance shall be repaired by the Contractor to the satisfaction of the Engineer at the expense of the Contractor.

E. Fill and compact all holes and other depressions prior to placement of new fill.

F. Fill areas to contours and elevations shown on the Drawings.

G. Maintain surface of cover components as shown on the Drawings to maintain a minimum grade for drainage.

H. Use unfrozen materials.

I. Immediately remove ponded water.

J. Transport borrow materials over land or roads identified in the Contractor's haul plan. Haul roads for heavy equipment over an area of the landfill cover system containing geomembrane (FML) shall have a minimum of 36 inch thick cover soil layer over the FML.

K. Perform access road maintenance including dust control by application of water as needed or by other suitable means approved by the Engineer. Additionally, road maintenance shall include periodic grading, as necessary, to remove ruts and to maintain construction access roads in a safe and sound condition.

L. Obey all applicable laws where borrow materials are transported along public roads, including but not limited to, laws relating to vehicle speed, vehicle weight, covering of loads and proper maintenance of the public road surfaces (i.e. dust).

## 3.02 COMMON EXCAVATION

A. Common Excavation is defined as the excavation of all materials that can be excavated, transported, and unloaded by the use of heavy ripping equipment and wheel tractor-scrapers with pusher tractors or that can be excavated and dumped into place or loaded onto hauling equipment by means of excavators equipped with attachments (such as shovel, bucket, backhoe, or clam shell) appropriate to the character of the materials and the site conditions.

B. Common excavation shall be made in accordance to the lines and grades shown in the Drawings. During progress of the work, it may be necessary or desirable for the Owner to vary the slopes or the dimensions of excavation from those shown in the Drawings.

C. To the extent they are needed, all suitable materials from the specified excavations shall be used in the construction of required permanent earth fill. The suitability of materials for specific purposes will be determined by the Engineer. The Contractor shall not waste or otherwise dispose of suitable excavated materials.

D. All necessary precautions shall be taken by the Contractor to preserve the materials below and beyond the lines of all excavation in the soundest possible condition. Any and all excavations made below and beyond the lines of excavation by the Contractor for any purpose or reason, except as may be otherwise specified or directed by the Engineer, shall be at the expense of the Contractor, and all such excess and other excavation shall be refilled, where required to complete the work, by the Contractor with on-site granular materials, unless other materials are required by the Engineer, furnished and placed at the expense of the Contractor.

E. No additional allowance will be made on account of excavated materials being wet or frozen or requiring ripping for removal.

## 3.03 WASTE CONSOLIDATION

A. Waste consolidation is defined as the movement of waste materials located within the landfill property. The waste may be frozen or frost free. No classification change will be made for the condition of the waste. Movement of existing topsoil or cover soils shall not be included as waste excavation. Waste consolidation requires applications of a soil daily cover or other suitable means of controlling the blowing of waste and odors from the landfill over both the cut and fill areas.

B. Waste materials excavated during the construction of final cover system shall be disposed of at designated areas within the limits of the landfill or graded to the proper contours, as shown on the Drawings or as directed by the Engineer.

C. Air monitoring of the breathing zone shall be completed in accordance with Section 1450 Health and Safety during work activities.

## 3.04 BRACING AND SHORING

A. Excavated surfaces too steep to be safe and stable if unsupported shall be supported as necessary to safeguard the work and workmen, to prevent sliding or settling of the adjacent ground, and to avoid damaging existing improvements. The width of the excavation shall be increased if necessary to provide space for sheeting, bracing, shoring, and other supporting installation. The Contractor shall furnish, place, and subsequently remove such supporting installations. No additional compensation shall be provided to the Contractor for this item.

## 3.05 STRUCTURE AND TRENCH EXCAVATION

A. Structure or trench excavations shall be completed to the specified elevations and to sufficient length and width to include allowance for forms, bracing and supports, and compaction of backfill, as necessary, before any concrete or earth fill is placed within the limits of the excavation.

## 3.06 BORROW EXCAVATION

A. Materials shall be obtained from the designated borrow areas. The extent and depth of borrow pits within the limits of the designated borrow areas shall be as shown on the Drawings or as directed by the Engineer.

B. Borrow areas shall be excavated and finely dressed in a manner to eliminate depressions, side slopes steeper than 25 percent, or other hazardous or unsightly conditions.

## 3.07 OVEREXCAVATION

A. Excavation in earth beyond the specified lines and grades shall be corrected by filling the resulting voids with approved compacted earth fill as specified herein or as directed by the Engineer, except that, if the earth is to become the subgrade for rock fill, sand or gravel bedding, or drain fill, the voids may be filled with material conforming to the specifications for the rock fill, bedding, or drain layers. All fill necessary to be placed because of overexcavation shall be the responsibility of the Contractor.

## 3.08 GAS COLLECTION/FOUNDATION LAYER FILL

A. The Gas Collection/Foundation Layer shall be placed over all exposed waste and beneath the geomembrane (FML) of the Final Cover System. It is anticipated that all material necessary to establish the finished contours of the Gas Collection/Foundation Layer is available within the boundaries of the project area and borrow area locations are as shown on the Drawings.

B. The materials shall be reworked as needed and placed in 6-inch lifts to the grades and dimensions indicated on the Drawings. Except for the uppermost 12 inches of the Gas Collection/Foundation Layer fill, materials shall be spread with a dozer and compacted by a minimum of two passes of the dozer or heavy rubber tired equipment approved by the Engineer. The uppermost 12 inches of Gas Collection/Foundation Layer fill shall be placed in 6-inch compacted lifts, moisture conditioned to ± 4 percent of optimum moisture content and compacted to a minimum of 90 percent of the standard Proctor determined in accordance with ASTM D698.

C. Filling shall proceed under the observation of the QC Personnel to the grades as specified on the Drawings. No grades more than 4H:1V (25%) or less then 25 Hi are allowed. The general grading of the site must be completed to the satisfaction of the Engineer.

D. Where excavations uncover subsurface conditions which, in the opinion of the Engineer, are unsuitable to receive subsequent fill layers, these materials shall be overexcavated in accordance with Section 02211 - Waste Consolidation and Handling and replaced with compacted fill to the lines and grades shown on the Drawings.

E. It is estimated that a total of 25,500 cubic yards of Gas Collection/Foundation Layer fill will be required for the project.

## 3.09 COVER SOIL LAYER

A. The work shall consist of furnishing and placing the Cover Soil Layer materials as shown on the Drawings and specified herein.

B. Cover Layer material shall be placed uniformly in layers NOT LESS THAN 12 INCHES DEEP over the geomembrane drainage net surfaces. The material shall be placed in a manner to avoid segregation of particle sizes and to insure the continuity and integrity of all zones.

C. Heavy construction traffic shall not be allowed to cross over the Cover Soil Layer (except for the equipment used for spreading Cover Soil Layer material over the drainage net surface) unless the thickness is a minimum of 36 inches.

D. Any damage to the geomembrane or drainage net surface occurring as a result of placement of the Cover Soil Layer shall be repaired before Cover Soil Layer placement is continued. The expense of the repair shall be the responsibility of the Contractor.

E. The Engineer will perform such tests as are required to verify that the Cover Soil Layer materials and the Cover Soil Layer in place meet the requirements of the Specifications. These tests are not intended to provide the Contractor with the information he needs to assure that the materials and workmanship meet the requirements of the Specifications, and their performance will not relieve the Contractor of the responsibility of performing his own tests for that purpose.

F. The Cover Soil Layer shall be made continuous over the entire drainage net and geomembrane surface as shown on the Drawings.

## 3.10 TOPSOIL

A. The work shall consist of importing suitable soil materials and spreading it on areas shown on the Drawings to specified depths.

B. Topsoil material shall not be placed until the Cover Soil Layer and other subgrade soils have been inspected and approved by the QC Personnel.

C. Topsoil material placement will be observed by the QC Personnel and shall conform to the dimensions shown in the Drawings.

D. Spreading shall not be done when the ground or Topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work. Surfaces designated to be covered shall be lightly scarified just prior to the spreading operation.

E. Stones larger than 1 inch in diameter, roots, weeds, debris, and foreign material shall be removed from the material while spreading.

F. Contractor shall avoid excessive compaction of the placed material due to site equipment travel.

G. After placement is completed, the surface of the Topsoil shall be finished to a reasonably smooth surface as approved by the Engineer.

H. The vegetative layer shall be covered in accordance with Section 02936 at the earliest possible time to stabilize the construction area and prevent erosion. A certified seeding contractor will be responsible for this work.

## 3.11 CONSTRUCTION OF STORMWATER CONTROL BERMS

A. The work shall consist of furnishing, placing, and compacting soil materials as shown on drawings for the stormwater control berms including the Type 1 Drain Layer, HDPE drain pipe, geotextile, and road base material for access road.

B. Stormwater control berms shall not be constructed until the subgrade has been inspected and approved by the Engineer. Stormwater control berm material shall be placed uniformly in layers not less than 12 inches. The material shall be placed in a manner to avoid segregation of particle sizes and to ensure the continuity and integrity of all zones.

C. Compaction of stormwater berms with a smooth drum compactor will be initiated after a 24 inch thickness of Cover Soil has been placed over the geomembrane (FML) or drainage net.

D. Construct stormwater control berms to lines and cross sections shown on the Drawings and maintain a minimum of 2 percent grade on the up-slope flow line. Layout of stormwater control berms must be field verified to maintain the minimum 2 percent grade.

E. Filter Fabric installation is described in Section 02235 - Filter Fabric.

F. HDPE Pipe installation is described in Section 02715 - HDPE Pipe.

G. HDPE pipe shall be daylighted to the grades and configuration shown in the Drawings.

## 3.12 CONSTRUCTION OF ACCESS ROAD

A. The work shall consist of furnishing, placing, and compacting soil materials as shown on drawings for the access road.

B. Subgrade surfaces shall be clean and free of organic matter, loose soil, foreign substances, and standing water when the access road is constructed.

C. The access road shall not be constructed until the subgrade has been inspected and approved by the Engineer. Access road material shall be placed uniformly in layers 12 inches thick. The material shall be placed in a manner to avoid segregation of particle sizes and to ensure the continuity and integrity of all zones.

D. Compaction of access road material with a smooth drum vibratory roller shall not be initiated until a minimum of 24 inches of Cover Soil Layer fill has been placed over the geomembrane (FML).

E. Construct access road to lines and cross sections shown and maintain grades on up-slope ditch line shown on Drawings.

## 3.13 STORMWATER CULVERT INSTALLATION

A. Pipe culvert shall be installed with the lower quarter of the circumference firmly supported. Shaping of the bedding material shall be required along the entire length of the structure.

B. Pipe culvert shall be aligned and sloped according to the elevations shown on the Drawings. Couplings or connecting bands shall be properly installed using all necessary tools to guarantee proper culvert strength and tightness to prevent infiltration and outflow of water through the joints

C. Fill materials under haunches and around the structure shall be placed alternatively in 6 inch layers on both sides of the pipe to permit thorough tamping. Tamping shall be performed with hand or mechanical equipment, tamping rollers or vibrating compactors, depending on field conditions.

D. The alignment and invert elevations of the ditches and culverts shall be confirmed by the Contractor by survey and documented on the as-built plans.

## 3.14 PRECONSTRUCTION MATERIAL QUALITY EVALUATION

A. Type 1 Drain Layer:

1. ASTM C 136 and C 117 - Grain Size Distribution: 3 tests per source.
2. ASTM C 88 - Soundness: 3 tests per source.

B. Material Quality Evaluation shall be performed by the Contractor.

## 3.15 CONSTRUCTION QUALITY CONTROL

A. Requirements Include:

1. Inspection during construction shall consist of (1) visual inspection of the work, and (2) field and laboratory tests. All field and laboratory tests shall be conducted on samples taken from material during the course of the work.
2. Field Samples of soil materials shall be collected in accordance with ASTM D 75.
3. Compaction testing of Gas Collection/Foundation Layer fill will be performed in accordance with ASTM D 698.
4. Contractor will inform the QC Personnel when, in his opinion, the results of mechanical compactive effort indicate that the specified percent compaction has been achieved.
5. Contractor shall remove Work, replace, and retest at no cost to the Group where testing indicates Work not meeting the specified requirements.
6. Contractor shall be responsible for surveying the approximate location and elevation of each test.
7. Questions concerning the accuracy of any single test shall be addressed by retesting in the same or adjacent location at the same elevation or material lift.
8. Questions concerning the accuracy of the equipment shall be addressed by utilizing other equipment for confirmation purposes.
9. Field surveys shall be the responsibility of the Contractor and performed by a qualified land surveyor to verify proper total layer thicknesses and construction at the proper locations and elevations.

   Survey data shall be collected at any critical location as designated by the Engineer, at points a maximum of 100 feet apart or a minimum of 6 points per grade at least at the following locations:

   a. top of gas collection/foundation layer

b. top of geomembrane (FML)
c. top of cover soil layer
d. top of topsoil layer
e. Site improvements including storm water drainage channels and basins; stakes for gradient, cover system layer material; utility locations, slopes, invert elevations; and stormwater structures.

Final surveys will be performed by the Contractor's Surveyor to verify elevations of cover component items are within the design limits established by the project Drawings and Specifications.

10. Visual observations shall be performed for all designed construction components. In addition, special attention shall be given to the character and condition of the placement surface; water content, density, and other pertinent physical properties of the compacted soil; loose and compacted thicknesses and elevations; lift scarification and bonding procedures; effects of equipment on the construction surface; and the number of passes required to compact each lift.

11. Additional testing shall be used or frequency of testing may be increased at the discretion of the QC Personnel and/or the Engineer when visual observations indicate a concern.

B. The test program for the Gas Collection/Foundation Layer fill includes:

1. ASTM D 2922-81 - Field Density and Water Content by Nuclear Method: 1 test per 1600 cubic yards or 1 test per acre.
2. ASTM D 698-78 - Moisture-Density Relations (Standard Proctor): 1 test per 8,000 cubic yards or 1 test per acre.
3. D1140 - Mechanical Analysis: 1 test per 1,000 cubic yards or 2 tests per acre.

C. In addition to these requirements listed in Section 4.5.7 of the CQAP, the test requirements for the Topsoil prior to placement will include:

1. ASTM D 422-63 - Grain Size Distribution: 1 test per acre.
2. ASTM D 2488-9 - Visual Classification of Soils: 1 test per acre.
3. USDA Standard Testing of Soil Nutrients including: pH, extractable nitrogen, extractable phosphorous and extractable potassium at a frequency of one (1) test per acre.

****END OF SECTION ****

# SECTION 02235
# FILTER FABRIC

## PART 1 . GENERAL

### 1.01 SECTION INCLUDES

A. Supplying all materials, labor and equipment to provide and place filter fabric around the perforated HDPE pipe and the Type 1 Drain Layer.

B. Supplying all materials, labor and equipment for use in the passive landfill gas venting trenches as shown on the Drawings.

### 1.02 RELATED SECTIONS

A. Section 02220 - Earthwork

B. Section 02715 - HDPE Pipe

### 1.03 SUBMITTALS

A. All material properties sheets, test reports and quality control certificates for the filter fabric material shall be supplied to the Engineer prior to installation.

### 1.04 MEASUREMENT AND PAYMENT

A. No separate measurement or payment will be made for the Work performed for installation of the Filter Fabric. Costs for Filter Fabric materials and installation described in this Section shall be included in the Unit Prices and Lump Sum prices bid in the Bid Schedule for items requiring filter fabric.

## PART 2 PRODUCTS

### 2.01 MATERIALS

A. The filter fabric shall be a nonwoven sheet formed of thermally bonded continuous filaments of preferentially orientated isotactic polypropylene. Material shall be TYPAR 3601 or equivalent, meeting the requirements shown below, subject to approval by the Engineer. The fabric shall be a minimum of 20 feet wide and free of defects or flaws which significantly affect its properties.

| Property | Test Method ASTM References | Specification |
|---|---|---|
| Grab strength | ASTM D 4632 | ≥400 lbs. |
| Grab elongation | ASTM D 4632 | ≥70 |
| Trapezoid tear strength | ASTM D 4533 | ≥150 lbs. |
| Puncture strength | ASTM D 3787 | ≥200 lbs. |
| Mullen burst strength | ASTM D 3786 | ≥700 psi |
| Permeability | ASTM D 4491 | $\geq 1 \times 10^{-1}$ cm/sec |

B. Weight of fabric to be used in all site applications where as indicated in the Drawings shall be 10 ounces per square yard.

## PART 3 EXECUTION

### 3.01 INSTALLATION IN DRAINAGE DITCH

A. The fabric shall be installed around the Type 1 Drain Layer Material as shown on the Drawings.

B. The fabric shall be unrolled as smooth and wrinkle free as possible. The fabric shall be overlapped a minimum of 2 feet unless otherwise specified by the Engineer.

C. Material shall not be exposed more than seven days to sunlight nor to precipitation prior to placement.

## 3.02 INSTALLATION IN PASSIVE LANDFILL GAS VENT TRENCH

A. The fabric shall be placed in the excavated trench once it conforms to the configuration and dimensions indicated in the Drawings.

B. Rock backfill shall be placed over the geotextile filling the trench to approximately 2 feet deep.

C. Perforated HDPE pipe shall be placed over the top of existing rock surface.

D. The remaining 2 feet of trench shall be backfilled with rock backfill.

E. Fold geotextile over the top of the trench overlapping the fabric edges as shown on the Drawings.

F. Material shall not be exposed more than seven days to sunlight nor to precipitation prior to placement.

## 3.03 CONSTRUCTION QUALITY ASSURANCE

A. Upon arrival at the site, the Contractor and the Engineer shall inspect all materials for damage during transportation, loading or unloading. Damaged materials shall be rejected and removed from the site.

B. The Engineer shall inspect filter fabric, after placement, for damage caused by placement operations or by weather. Damaged fabric, as judged by the Engineer, will be marked and removed from the area. The Engineer shall also observe that:

1. The required field overlaps are obtained;
2. The fabric has not shifted or moved;

C. After placement, and prior to subsequent construction, the Engineer will observe that suitable protective measures have been taken to prevent UV degradation on in-place fabrics.

****END OF SECTION ****

# SECTION 02240
# DRAINAGE NET

## PART 1 GENERAL

### 1.01 SECTION INCLUDES

A. Material Requirements

B. Placement of Drainage Net

### 1.02 RELATED SECTIONS

A. Section 02715 HDPE Pipe

B. Section 02778 Geomembrane

### 1.03 DESCRIPTION OF THE WORK

A. Approximately 631,620 square feet of drainage net shall be placed on top of the completed areas of geomembrane.

B. Placement of the drainage net shall occur immediately after approval of the geomembrane surfaces and be in a single 5-day period. Work shall be coordinated with the installation and approval of the geomembrane.

C. Drainage net placement shall be completed prior to commencing placement of the cover soil layer.

## 1.04 MEASUREMENT AND PAYMENT

A. Measurement for drainage net shall be by surveying the area of materials placed. The survey shall be conducted on areas approved by the Engineer. Survey points on edge of completed, approved work shall not be spaced greater than 50 feet.

B. Payment for drainage net shall be as described in the Unit Quantity Bid in the Bid Schedule. Such payment shall constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Drainage net shall be manufactured by extending two sets of polyethylene strands to form a three (3) dimensional structure to provide planar water flow.

B. The drainage net shall contain stabilizers to prevent ultraviolet degradation.

C. The drainage net shall be TEX-NET TN3002CN or approved equal. The drainage net shall conform to the properties detailed below:

| PROPERTY | TEST METHOD | UNIT | QUALIFIER | VALUE |
|---|---|---|---|---|
| Thickness | ASTM D5199 | Inches | Minimum | 0.200 |
| Tensile Strength | ASTM D5035 | 16 lb/in | Minimum | 0.940 |
| Carbon Black | ASTM D4218 | % | Minimum | 2.0 |
| Density | ASTM D1505 | $g/cm^3$ | Minimum | 0.940 |

D. The geotextile filter media shall be a 6 ounce non-woven continuous filament needle punched fabric.

E. The geocomposite shall be manufactured by heat bonding the geotextile to the HDPE drainage net on both sides. No burn through geotextiles shall be permitted. No glue or adhesive shall be permitted.

F. Drainage net shall have a minimum transmissivity of $3x10^{-5}$ $m^2$/second as per ASTM D 4716 at 2000 PSF.

## 2.02 MANUFACTURERS STATEMENT

A. The manufacturer shall submit on request, notarized certifications indicating the material meets the above specifications, signed by an authorized employee.

# PART 3 EXECUTION

## 3.01 DRAINAGE NET PLACEMENT

A. After the geomembrane has been placed, inspected and approved by the Engineer, the Contractor shall initiate placement of the drainage net.

B. On sideslopes the drainage net will be securely anchored, and then rolled down the slope in such a manner as to continually keep the geocomposite in tension. If necessary, the drainage net will be positioned by hand after being unrolled to minimize wrinkles.

C. In the presence of winds, all drainage net will be secured by suitable methods. The temporary weighted material will be left in place until replaced with cover material as shown on the design plans and specifications.

D. Cutting should be done according to manufacturer's recommendations.

E. The installer will take necessary precautions to prevent damage to any underlying layers during placement of the geocomposite.

F. During placement of design net, care will be taken not to entrap any stones, excessive dust, or moisture that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane.

## 3.02 OVERLAPS AND JOINING

A. The following requirements will be used with regard to the overlapping and joining of drainage net rolls:

1. Adjacent rolls will be overlapped by a minimum of 4 inches.
2. These overlaps shall be secured by tying to each other.
3. Tying can be achieved by strings, plastic fasteners, or polymer braid. Tying devices will be white or brightly colored for easy identification. Metallic devices will not be used in any circumstances.
4. No horizontal joints or overlaps will be allowed on slopes greater than 5 horizontal to 1 vertical (i.e., seams will be along, not across, the slope), except as part of a patch.
5. The installer will pay particular attention to the overlap areas to ensure that no earthen or foreign materials could be inadvertently trapped beneath the drainage net.

B. Any tears or other defects in the drainage net will be repaired by placing a patch extending a minimum of 2 feet beyond the edges of the hole or tear. The patch will be secured to the original drainage net by tying every 6 inches. If the tear or other defect width is more than 50 percent of the roll width, the damaged area will be cut out and replaced with new drainage net material. Tying devices will be as indicated in Subsection 3.2.A. The Engineer will examine and document that the repair of any drainage net is performed according to the above procedure.

## 3.03 PLACEMENT OF SOIL MATERIALS

A. The Contractor will place all soil materials located on top of the drainage net in such a manner as to minimize the following:

1. Damage of the drainage net.
2. Slippage of the drainage net on underlying layers.
3. Excessive tensile stresses imposed on the drainage net.

****END OF SECTION****

## SECTION 02270
## SLOPE PROTECTION AND EROSION CONTROL

### 1.0 GENERAL

#### 1.01 SECTION INCLUDES

A. Furnishing and installation of construction erosion control measures.

#### 1.02 RELATED SECTIONS

A. Section 02110 - Clearing, Stripping and Grubbing

B. Section 02215 - Site Preparation

C. Section 02220 - Earthwork

D. Section 02936 - Seeding

#### 1.03 REGULATORY REQUIREMENTS

A. Slope protection and erosion control shall be performed in accordance with all applicable laws and regulations. Except as supplemented or otherwise specifically modified herein, the site-specific temporary slope protection and erosion control activities shall be in compliance with the requirements and guidelines of "Soil Erosion and Sedimentation Control Act", State of Michigan Public Act No. 347 of the Public Acts of 1973, being sections 282.101 to 282.117 of the Michigan Compiled Laws.

B. At all times, comply with federal, state, and local regulations in force to prevent pollution of air and water.

C. Perform all activities in accordance with the Site Safety Plan (SSP) and under the supervision of the Site Safety and Health Officer (SSHO).

## 1.04 GENERAL

A. Erosion control measures shall be utilized throughout the construction to prevent erosion during and after construction until permanent vegetation is established. Eroded materials shall not be allowed to leave the project site.

B. Eroded materials shall not be deposited in any waterway.

## 1.05 MEASUREMENT AND PAYMENT

A. For items of work for which specific Unit Prices or Lump Sum prices are established in the contract, payment for such items will be made at the Unit Prices or Lump Sum prices bid in the Bid Schedule for the corresponding item. Such payment will constitute full compensation for all labor, equipment, materials, and all other items necessary and incidental to the completion of the Work.

B. Compensation for any item of work described in the Contract but not listed in the Bid Schedule will be included in the payment for the item of work to which it is made subsidiary.

# PART 2 PRODUCTS

## 2.01 SILT FENCE

A. Contractor shall select a commercially available product which conforms with the requirements for "Geotextile Silt Fence" as presented in Section 8.09 of the Michigan Department of Transportation Standard Specifications for Construction and/or as detailed in Sheet 10.

## PART 3 EXECUTION

### 3.01 SLOPE PROTECTION AND EROSION CONTROL

A. The slope protection and erosion control will be consistent with the requirements of these specifications:

1. Contractor shall perform all work in accordance with this Specification. No site work shall be performed until the implementation schedule and methods of operation associated with slope protection and erosion control have been provided to and accepted by the Engineer.
2. Minimize soil exposure to construction water, rain or other surface runoff by scheduling grading and construction to limit areas exposed to flowing water at any time.
3. Retain natural vegetation where directed by Engineer.
4. Vegetate and mulch denuded areas to protect them from rains.
5. Divert runoff away from steep denuded slopes or other critical areas with berms, barriers or ditches.
6. Minimize length and steepness of temporary cut and fill slopes by benching, terracing or constructing diversion structures.
7. Trap sediment-laden runoff in basins to allow soil particles to settle out before flows are released to receiving waters.

### 3.02 GEOFABRIC SILT FENCE INSTALLATION

A. Work shall consist of erecting, maintaining, removing and disposing of erosion/sediment barriers, consisting of post or pole supported geotextile.

B. Installation shall be accomplished as described in the Contractor's approved Erosion Control Plan or with the approval of the Engineer, in accordance with the manufacturer's published recommended practice and in accordance with state and/or local permits.

C. Sections of the fence which are damaged due to the Contractor's operations or negligence during erection or during the contract time shall, to the satisfaction of the Engineer, be immediately mended, patched or replaced at the Contractor's expense.

*** * END OF SECTION * ***

# SECTION 02671
# MONITORING WELL ABANDONMENT

## 1.0 GENERAL

### 1.01 SECTION INCLUDES

A. Furnish all labor, materials, equipment and incidentals required for abandonment of existing on-site and of-site monitoring wells as directed by the Engineer.

### 1.02 RELATED SECTIONS (NOT USED)

### 1.03 REGULATORY REQUIREMENTS

A. Abandonment shall be performed in accordance with all applicable laws and regulations including State of Michigan Act No. 315 of the Public Acts of 1969, As Amended: Mineral Well Act and Promulgated Rules.

B. At all times, comply with federal, state, and local regulations in force to prevent pollution of air and water.

C. Perform all site clearing activities in accordance with the Site Safety Plan (SSP) and under the supervision of the Site Safety and Health Officer (SSHO).

### 1.04 SUBMITTALS

A. Qualifications of a well contractor licensed in the State of Michigan who will perform the work.

B. Upon completion of each well abandonment, the Contractor shall submit to the Engineer a report to include the following:

1. Total depth of the abandoned well.
2. Depth or location of any lost grout.
3. Diameter of the well bore.
4. Amount of cement grout (number of bags and type) used to fill the borehole.
5. The depth for all stages of cement grouting operations.
6. Other pertinent data requested by the Engineer.

### 1.05 MEASUREMENT AND PAYMENT

A. For items of work for which specific Unit Prices or Lump Sum prices are established in the contract, payment for such items will be made at the Unit Prices or Lump Sum prices bid in the Bid Schedule for the corresponding item. Such payment will constitute full compensation for all labor, equipment, materials, and all other items necessary and incidental to the completion of the Work.

B. Compensation for any item of work described in the Contract but not listed in the Bid Schedule will be included in the payment for the item of work to which it is made subsidiary.

## PART 2 PRODUCTS

### 2.01 GROUT

A. Grout used to fill the borehole from the bottom of the casing to ground surface shall be proportioned of Type I or Type II (ASTM C-150) Portland cement mixed with 3 to 4 percent by weight of cement of bentonite clay..

## PART 3 EXECUTION

### 3.01 EXISTING WELL ABANDONMENT

A. If practical, the well casing shall be pulled from the ground while sealing with grout. If pulling the casing is not pratical, the casing shall be cut off at least 2 feet below grade.

B. All grouting and sealing of the wells shall be performed in the presence of the Engineer. The Contractor shall pump the grout with the bottom of the tremie pipe no closer than 3 feet from the top of casing. The Contractor shall take full responsibility for cementing operations, including volumes to be used and insuring that the hole and/or well is properly abandoned.

C. All procedures shall be in accordance with State of Michigan Act No. 315: Mineral Well Act and Promulgated Rules.

## 3.02 DISPOSAL OF DEBRIS

A. Unless otherwise specified, all materials removed from the boreholes shall be buried at on-site locations approved by the Owner or otherwise disposed of as approved by the Owner.

*** * END OF SECTION * ***

# SECTION 02715

# HDPE PIPE

## PART I GENERAL

### 1.01 SCOPE OF APPLICATION

A. Supplying all materials, labor and equipment to provide and place HDPE drainage pipe in stormwater control berms and the landfill to drain system.

B. Supplying all materials, labor and equipment to provide and gas vent trenches and vent risers.

### 1.02 RELATED SECTIONS

A. Section 02220 - Earthwork

B. Section 02235 - Filter Fabric.

### 1.03 SUBMITTALS

A. The Contractor shall submit pipe manufacturer's specifications to the Engineer for approval prior to ordering pipe.

### 1.04 MEASUREMENT AND PAYMENT

A. No quantity measurement or separate payment will be made for the work performed for pipes and pipe fittings as described in this Section. Costs for pipes and pipe fittings described in this Section shall be included in the Unit Prices and Lump Sum prices bid in the Bid Schedule for items requiring pipe or pipe fittings.

## PART 2 PRODUCTS

### 2.01 MATERIALS

A. HDPE pipe material to be used for the passive landfill gas venting system shall be Driscopipe 1000, manufactured by Phillips Petroleum Co., or equivalent, meeting the requirements shown below.

| Property | ASTM Reference | Specification |
|---|---|---|
| Density, gms/cc | ASTM D 1505 | ≥0.95 |
| Environmental Stress Cracking Resistance, (Condition A, B & C) Hrs | ASTM D 1693 | >1,500 |
| Tesile Strength, Yield (2in./min) psi | ASTM D 638 (Die IV) | >3,000 |
| Elongation (2in./min), % | ASTM D 638 | >500 |
| Brittleness Temperature, °F | ASTM D 746 | <-100 |
| Modules of Elasticity, psi | ASTM D 638 | ≥80,000 |
| Coefficient of Linear Thermal Expansion, In/In/°F | ASTM D 696 | $<5 \times 10^{-4}$ |

B. HDPE to be used for the subdrain system and passive gas venting system shall have a corrugated interior and exterior. Pipe diameter shall be a nominal 4 inches and meet the requirements of AASHTO M252. Pipe shall be joined by internal couplers extending at least two full corrugations into the end of each pipe. Fittings shall conform to AASHTO M252 or AASHTO M294. Slotted perforations shall be cleanly cut and uniformly spaced along the length of the tubing. The water inlet area shall be a minimum of 1 square inch per lineal foot of tubing.

## 3.01 SUBCONTRACTOR

A. HDPE pipe shall be installed by a qualified, experienced contractor. The pipe installer's experience and qualifications shall be submitted to the Engineer for approval before installation of the pipe.

## 3.02 HDPE PIPE INSTALLATION -SUBDRAIN SYSTEM

A. HDPE pipe shall be installed to the grades and alignments shown on the Drawings. All pipe connections shall be performed in accordance with the manufacturer's specification.

B. Bedding and Backfill

1. Bedding and backfill for the subdrain system pipes shall consist of Type 1 drainage material, as shown on the Drawings.

C. The interior of the pipe, fittings, and couplings shall be clean and free from contamination when installed. Effective means shall be taken to prevent the entrance of foreign matter following installation.

D. Corrugated perforated HDPE pipe and Type 1 drainage layer bedding used in the landfill subdrain system shall be wrapped with filter fabric as specified on the Drawings.

E. When the work is not in progress, open ends of pipe and fittings shall be securely closed. The piping shall be placed when weather conditions are suitable. All pipe in place shall be approved by the Engineer as to line, grade, bedding and proper joint construction before backfilling. In all backfilling operations, the Contractor shall be responsible for preventing damage to or misalignment of the pipe.

## 3.03 HDPE PIPE INSTALLATION - PASSIVE LANDFILL GAS VENTING SYSTEM

A. HDPE pipe shall be installed to the depths, configurations and alignments shown on the Drawings. All pipe, tee and elbow connections shall be performed in accordance with the manufacturers specifications. Procedures proposed for HDPE pipe welding shall be submitted to the Engineer for approval prior to initiating the work.

B. Bedding and backfill for the passive landfill gas venting system shall consist of a coarse washed rock backfill approved by the Engineer as shown on the Drawings.

C. Perforated pipe and rock backfill used in the passive landfill gas venting system shall be wrapped with filter fabric as specified on the Drawings.

D. The interior of the pipe and fittings shall be clean and free of debris and pipe shavings when installed. Effective means shall be taken to prevent the entrance of foreign matter following installation.

E. All pipe in place shall be approved by the Engineer as to line, grade, bedding and proper joint construction before backfilling.

****END OF SECTION****

## SECTION 02778
## GEOMEMBRANE

### PART 1 GENERAL

### 1.01 SUMMARY

A. Scope of Work:

1. Manufacture, fabrication, furnishing, and installation of textured, 40 mil. linear low density polyethylene (LLDPE) geomembrane for landfill cover.

B. Related Sections:

1. Section 01300 - Submittals
2. Section 02220 - Earthwork.

### 1.02 REFERENCE STANDARDS

A. Reference Standards: Comply with applicable provisions and recommendations of the following except otherwise shown or specified.

1. D638 - Test Method for Tensile Properties of Plastics.
2. ASTM D751 - Method of Testing Coated Fabrics.
3. ASTM D792 - Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement.
4. ASTM D1004 - Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
5. ASTM D1204 - Test Method for Linear Dimensional Changes of Non-rigid Thermoplastic Sheeting or Film at Elevated Temperature.
6. ASTM D1238 - Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
7. ASTM D1505 - Test Method for Density of Plastics by the Density-Gradient Technique.

8. ASTM D1593 - Specification for Nongrid Vinyl Chloride Plastic Sheeting.
9. ASTM D1603 - Test Method for Carbon Black in Olefin Plastics.
10. ASTM D1693 - Test Method for Environmental Stress-Cracking of Ethylene Plastics.
11. ASTM D4437 - Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
12. ASTM D 5321 - Test Method for Determining the Coefficient of Soil and Geosynthetics or Geosynthetics and Geosynthetics Friction by the Direct Shear Method.
13. FTMS No. 101C, Method 2065 - Puncture Resistance and Elongation Test (1/8-inch Radius Probe Method).
14. GRI GM6 - Standard Practice for Pressurized Air Channel Test for Dual Seamed Geomembranes.

## 1.03 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:
    a. Manufacturer shall have at least 5 years continuous experience in manufacture of LLDPE geomembrane rolls and/or experience totaling 2 million sq.ft of manufactured rolls for at least 10 completed facilities.
    b. Manufacturer must be listed by NSF (National Sanitation Foundation) Standard 54 as meeting all requirements for manufacturing geomembrane.
2. Installer:
    a. Installer shall have at least 5 years continuous experience in installation of geomembrane and/or experience totaling 2 million sq.ft of installed HDPE or LLDPE geomembrane for at least 10 completed facilities.
    b. Personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests. At least one seamer shall have experience seaming a minimum of 1 million sq.ft of geomembrane using same type of seaming apparatus in

use on-site. The most experienced seamer, "master seamer", shall have experience seaming textured material and shall provide direct supervision, as required, over less experienced seamers.

B. Quality Assurance Program: Manufacturer/Fabricator/Installer shall agree to participate in and conform with all items and requirements of quality assurance program as outlined in this Specification and the Construction Quality Assurance Plan.

## 1.04 SUBMITTALS

A. Submit in accordance with Section 01340 and 01341.

B. Raw Materials:

1. Copy of quality control certificates issued by LLDPE resin suppliers.
2. Production date(s) of LLDPE resin.
3. Reports on tests conducted to confirm quality of LLDPE resin used to manufacture geomembrane rolls assigned to considered facility. Report shall indicate compliance with requirements in Part 2.
4. Statement that no reclaimed polymer is added to resin during manufacture of actual geomembrane to be used in this project.

C. Geomembrane Roll Production: Copy of quality control certificates indicating compliance with requirements of Part 2.

D. Installation layout identifying placement patterns and seams, as well as any variance or additional details which deviate from engineering drawings. Layout shall be drawn to scale and shall be adequate for use as construction plan, and shall include information such as dimensions and details.

E. Installation Schedule as part of Construction Progress Schedule.

F. List of personnel performing field seaming operation, along with pertinent experience information.

G. Description of seaming apparatus to be used and extrudate properties.

H. Remittance during installation:
   1. Quality control documentation.
   2. Daily subgrade acceptance by installer.

I. Remittance after completion of installation:
   1. Geomembrane installation certification.

J. Copy of warranty obtained from Manufacturer/Fabricator/Installer.

## 1.05 GEOMEMBRANE DELIVERY, STORAGE, AND HANDLING

A. Transportation: Handle geomembrane rolls or panels by appropriate means so as to cause no damage.

B. On-site Storage: Storage of geomembrane is responsibility of Installer.

C. On-site Handling: Use appropriate handling equipment when moving rolled or folded geomembrane from one place to another. Instructions for moving shall be given by Manufacturer/Fabricator.

## 1.06 WARRANTY

A. Provide written 2-year warranty from date of substantial completion from Manufacturer/Fabricator/Installer. Warranty shall address quality of material and workmanship.

# PART 2 PRODUCTS

## 2.01 MANUFACTURERS

A. National Seal Company, Aurora, Illinois.

B. GSE Lining Technology, Inc., Houston, Texas.

C. Poly-Flex, Inc., Grand Prairie, Texas.

D. Or other Manufacturer approved by the Engineer.

## 2.02 GEOMEMBRANE

A. The textured and smooth LLDPE geomembrane shall be manufactured of new, first-quality, polyethylene resin, and shall be designed and manufactured specifically for the intended purpose. Do not add reclaimed polymer to resin; however, use of polymer recycled during manufacturing process may be permitted if performed with appropriate cleanliness and if recycled polymer does not exceed 2% by weight. Geomembrane shall have the following values:

## LLDPE GEOMEMBRANE PROPERTIES

| Property | Qualifier | Unit | Specified Value | Test Method |
|---|---|---|---|---|
| Thickness | minimum<br>nominal | mils<br>mils | 37<br>40 | ASTM D1593 or D751 |
| Density | minimum | g/cu cm | 0.929 | ASTM D792 or D1505 |
| Melt Flow Index | maximum | g/10 min. | 0.5 | ASTM D1238 |
| Tensile Strength at Break | minimum | lb/in. width | 228 | ASTM D638 |
| Elongation at Break | minimum | % | 700 | ASTM D638 |
| Tear Resistance | minimum | lb | 42 | ASTM D1004 |
| Puncture Resistance | minimum | lb | 78 | FTMS 101C/2065 |
| Carbon Black Content | range | % | 2-3 | ASTM D1603 |
| Environmental Stress Cracks | minimum | hours | 1,500 | ASTM D1693 |
| Modulous of Elasticity | minimum | psi | 15,000 | |
| Residual Interface Friction Angle with Ottowa Sand (smooth) | minimum | degrees | 19 | ASTM D 5321 |
| Residual Interface Friction Angle with Ottowa Sand | minimum | degrees | 30 | ASTM D 5321 |

B. In addition, geomembrane shall:

1. Consist of unreinforced textured LLDPE containing 1% by weight maximum additives, fillers, or extenders.
2. Contain carbon black for ultraviolet light resistance.

3. Not have striations, pinholes or bubbles on surface.
4. Be produced so as to be free of holes, blisters, undispersed raw materials or any sign of contamination by foreign matter.

C. Geomembrane seams shall meet following requirements:

**LLDPE**
**SEAM PROPERTIES**

| PROPERTY | QUALIFIER | UNIT | SPECIFIED VALUE | TEST METHOD |
|---|---|---|---|---|
| Shear Strength (at yield point) | minimum | lb/in. width | 120 and FTB[1] | ASTM D4437 |
| Peel Adhesion (at yield point) | minimum | lb/in. width | 70 and FTB[1] | ASTM D4437 |

NOTES: [1] = FTB = Film Tear Bond.

D. Rolls and Panels:
1. Supply geomembranes as panels or in rolls. Panel is unit area of geomembrane to be seamed in field. Two cases can be considered:
   a. If geomembrane is not fabricated into panels in factory, field panel is roll or portion of roll cut in field.
   b. If geomembrane is fabricated into factory panels, field panel is factory panel cut in field.
2. Panel size shall be determined by Installer Shop Drawings showing layout and dimensions of panels in structure.
3. Panel Label and Identification:
   a. Labels on each roll or factory panel shall identify thickness of material, length, and width of roll or factory panel; Manufacturer; and directions to unroll material.
   b. Designate each roll or factory panel with panel number (identification code) consistent with layout plan. Panel is unit

area of geomembrane to be seamed in field (e.g., one roll may be cut into several panels). Position panels on-site as shown in layout drawings.

c. Follow instructions on boxes or wrapping containing geomembrane materials to ensure panels are unrolled in proper direction for seaming.

E. Fabricated Seams and Field Seams: Approved processes for seaming are extrusion welding and fusion welding. Only apparatus which has been specifically approved by make and model shall be used. Proposed alternate processes shall be documented and submitted for approval. Resin used for extrusion welding shall be produced from same resin type as geomembrane. Physical properties shall be same as those of resin used in manufacturer of geomembrane.

## PART 3 EXECUTION

### 3.01 EARTHWORK PREPARATION

A. General:

1. Contractor shall remove protruding angular gravel from geomembrane subgrade. Grade stakes or hubs shall also be removed from subgrade prior to geomembrane placement.
2. Installer shall provide in writing that surface on which geomembrane is to be installed is acceptable for each day that geomembrane is installed.
3. After supporting soil is accepted by Installer, it shall be Installer's responsibility to indicate to Contractor any change in supporting soil condition that may require repair work. Special care must be taken to maintain prepared soil surface. Soil surface shall be observed daily to evaluate desiccation cracking. Damage to subgrade caused by this installation shall be repaired at Contractor's expense.
4. Do not place geomembrane in area which has become softened by precipitation, i.e., unconfined compressive strength less than 1.0 ton/sq ft.

## 3.02 GEOMEMBRANE PLACEMENT

A. Install panels parallel to slopes and seam panels immediately or after all panels have been placed.

B. Weather Conditions:
   1. Do not place panels at ambient temperature below $5^{\circ}$C ($40^{\circ}$F) without performing proper procedures recommended by Manufacturer and approved by the Engineer.
   2. Do not place during precipitation, in presence of excessive moisture (e.g., fog, dew), in area of ponded water, or during excessive winds.

C. Placement:
   1. Equipment used shall not damage geomembrane by handling, trafficking, leakage of hydrocarbons (such as gasoline or oil) or other means.
   2. Personnel working on geomembrane shall not smoke, wear damaging shoes, or engage in other activities which could damage geomembrane.
   3. Methods used to unroll panels shall not cause scratches or crimps in geomembrane and shall not damage supporting soil.
   4. Method used to place panels shall minimize wrinkles (especially differential wrinkles between adjacent panels).
   5. Place adequate loading (e.g., sand bags, tires) not likely to damage geomembrane, to prevent uplift by wind (in case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under panels).
   6. Direct contact with geomembrane shall be minimized, i.e., geomembrane in traffic areas shall be protected by geotextiles, extra geomembranes, or other suitable materials.

D. Damage:
   1. Any panel which, in judgment of Group's representative, becomes seriously damaged (such as torn or twisted permanently) shall be

replaced at no cost to Group. Less serious damage shall be repaired at the direction of the Engineer.

2. Remove rejected damaged panels or portions of rejected damaged panels from work area.

## 3.03 GEOMEMBRANE FIELD SEAMING

A. Seam Layout:

1. In general, orient seams parallel to line of maximum slope, i.e., oriented along, not across, slope. In corners and odd-shaped geometric locations, minimize numbers of field seams.
2. No horizontal seam shall be less than 5 ft from toe of slope.

B. Overlapping and Temporary Bonding:

1. Overlap panels by minimum of 4 in. for fusion welding or 3 in. for extrusion welding.
2. Procedure used to temporarily bond adjacent panels together shall not damage geomembrane; in particular, temperature of air at nozzle of any spot welding apparatus shall be controlled such that the geomembrane is not damaged.
3. No solvent or adhesive shall be used unless product is approved in writing by Engineer or Group (samples shall be submitted for testing and evaluation).

C. Seam Preparation:

1. Prior to seaming, seam area shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign material.
2. If seam overlap grinding is required, process shall be completed according to Manufacturer's instructions and in a way not damaging to geomembrane.
3. Align seams with fewest possible number of wrinkles and "fish mouths".

D. Seaming Equipment and Products:

1. General:

   a. Approved processes for field seaming are fusion welding and extrusion welding. Proposed alternate processes shall be documented and submitted for approval prior to use.

   b. Only use apparatus specifically approved by geomembrane Manufacturer.

   c. Seams shall meet specifications in Part 2.

2. Fusion Process:

   a. Use automated, vehicular-mounted fusion welding apparatus.

   b. Equip apparatus with gauges indicating applicable temperatures and pressures.

   c. Maintain one spare operable seaming apparatus on-site. Equipment used for seaming shall not damage geomembrane. Protect geomembrane from damage in heavily trafficked areas.

   d. Use movable protective layer directly below each overlap of geomembrane that is to be seamed to prevent build-up of moisture between sheets.

   e. Place electric generator on smooth base. Place smooth insulating plate or fabric beneath hot welding apparatus after use.

3. Extrusion Process:

   a. Use apparatus equipped with gauges giving temperature in apparatus and at nozzle.

   b. Provide documentation of extrudate to Engineer or Owner and certify that extrudate is compatible with specifications and is comprised of same resins as geomembrane.

   c. Maintain one spare operable seaming apparatus on-site. Equipment used for seaming shall not damage geomembrane. Protect geomembrane from damage in heavily trafficked areas.

   d. Purge exterior prior to beginning seam until all heat-degraded extrudate has been removed from barrel. When extruder is stopped, purge barrel of all heat-degraded extrudate.

e. Place electric generator on smooth base. Place smooth insulating plate or fabric beneath hot welding apparatus after use.

E. Weather Conditions for Seaming:

1. No seaming shall be attempted below $5^{\circ}C$ ($40^{\circ}F$) or above $40^{\circ}C$ ($104^{\circ}F$) without proper procedure from Manufacturer.
2. Between $5^{\circ}C$ ($40^{\circ}F$) and $10^{\circ}C$ ($50^{\circ}F$), seaming shall be possible if geomembrane is preheated by either sun or hot air device, and if there is not excessive cooling resulting from wind.
3. Above $10^{0}C$ ($50^{\circ}F$), no preheating shall be required.
4. Geomembrane shall be dry and protected from wind damage.
5. In the event of seaming below $5^{\circ}C$ ($40^{\circ}F$) or above $40^{\circ}C$ ($104^{\circ}F$), certify in writing that low-temperature or high-temperature seaming procedures does not cause any physical or chemical modification to geomembrane that will generate any short- or long-term damage to geomembrane.

F. General Seaming Procedures:

1. For fusion welding, provide temporary sacrificial or protective layer of plastic placed directly below each overlap of geomembrane to be seamed. This is to prevent moisture build-up between panels to be welded.
2. Seaming shall extend to outside edge of panels to be placed in anchor trench.
3. If required, provide firm substrate by using flat board, conveyor belt or similar hard surface directly under seam overlap to achieve proper support.
4. Cut "fish mouths" or wrinkles at seam overlaps along ridge of wrinkle in order to achieve flat overlap. Seam cut "fish mouths" or wrinkles. Patch any portion where overlap is inadequate with oval or round patch of same geomembrane extending a minimum of 6 in. beyond cut in each direction.

G. Trial Seams:

1. Trial seams shall be made on fragment pieces of geomembrane to confirm seaming conditions are adequate. Trial seams shall be made at beginning of each seaming period with at least two per day for each seaming apparatus used that day. Also, each seamer shall make at least one trial seam each day. QC Personnel may, at his/her discretion, require additional trial seams.
2. Trial seam sample shall be at least 3 ft long by 1 ft wide with seam centered lengthwise. Cut two adjoining specimens each 1 in. wide from trial seam sample. Test specimens in shear and peel using digital field tensiometer; specimen shall not fail in seam. If additional trial seam fails, seaming apparatus or seamer shall not be accepted and shall not be used for seaming until deficiencies are corrected and two consecutive successful full trial seams are achieved.

H. Nondestructive Seam Continuity Testing:

1. Nondestructively test field seams over their full length using vacuum test unit or air pressure (if double fusion process). Continuity testing shall be done as seaming work progresses, not at completion of field seaming.
2. Complete required repairs.
3. The following procedures shall apply to locations where seams cannot be nondestructively tested, as determined by Engineer or Owner:
    a. All such seams shall be cap-stripped with same geomembrane where possible.
    b. If seam is accessible to testing equipment prior to final installation, seam shall be nondestructively tested prior to final installation.
    c. If seam cannot be tested prior to final installation, seaming and cap-striping operations shall be observed by Resident Site Representative for uniformity and completeness.
4. Vacuum Testing:

a. Use following equipment:

- Vacuum box assembly consisting of rigid housing, transparent viewing window, soft neoprene gasket attached to bottom, port hole or valve assembly, and vacuum gauge.
- Steel vacuum tank and pump assembly equipped with pressure controller and pipe connections.
- Rubber pressure/vacuum hose with fittings and connections.
- Bucket and wide paint brush.
- Soapy solution.

b. Following procedures shall be followed:

- Energize vacuum pump and reduce tank pressure to approximately 6 in. of mercury (i.e., 3 lb/sq in. absolute).
- Wet strip of geomembrane approximately 12 in. by 48 in. with soapy solution.
- Place box over wetted area.
- Close bleed valve and open vacuum valve.
- Ensure leak-tight seal is created.
- For period of not less than 15 sec, examine geomembrane through viewing window for presence of soap bubbles.
- If no bubble(s) appear after 15 sec, close vacuum valve and open bleed valve, move box over next adjoining area with minimum 3 in. overlap, and repeat process.
- Mark areas where soap bubbles appear, and then repair those areas.

5. Air Pressure Testing (for double fusion seam only) based on GRI Test Method GM6:

a. Equipment:

- Air pump (manual or motor driven) equipped with pressure gauge capable of generating and sustaining a minimum pressure of 24 lb/sq in. for 40-mil thick geomembrane.

- Rubber hose with fittings and connections.
- Sharp hollow needle or other approved pressure feed device.

b. Following procedure shall be followed:

- Seal both ends of seam to be tested.
- Insert needle or other approved pressure feed device into tunnel created by fusion weld. Place protective cushion between air pump and geomembrane.
- Energize air pump to a minimum pressure of 24 lb/sq in. for 40-mil thick geomembrane and 27 lb/sq in. for 60-mil thick geomembrane, close valve, and sustain pressure for approximately 5 min.
- If pressure loss of more than 3 lb/sq in. for 60-mil thick geomembrane and 4 lb/sq in. for 40-mil thick geomembrane, is noticed, locate faulty area and repair.
- At end of test, cut end of seam opposite pressure feed device and watch gauge pressure drop to zero, check for air channel obstruction and repeat air pressure test. If gauge pressure does not drop to zero after repeating air pressure testing, then seam shall be tested with vacuum box.
- Remove needle or other approved pressure feed device and seal.

I. Destructive Seam Strength Testing:

1. Location and Frequency:

a. Conduct minimum of one test per 500 ft of seam length.

b. Maximum frequency of test locations shall be agreed upon by Installer and QC Personnel prior to commencement of installation.

c. Additional test locations, not to exceed agreed upon maximum frequency, shall be determined during seaming at the QC Personnel's discretion. Selection of such locations may be prompted by suspicion of excess crystallinith, contamination, offset welds, or any other potential cause of imperfect welding.

d. Installer shall not be informed in advance of locations where seam samples will be taken.

2. Sampling Procedure:

a. Cut samples as seaming progresses in order to obtain laboratory test results prior to completion of geomembrane installation. Number each sample and identify sample number and location on panel layout drawing.

b. Immediately repair holes in geomembrane resulting from destructive seam sampling. Test continuity of new seams in repaired area according to Nondestructive Seam Continuity Testing.

3. Sample Size:

a. Samples shall be 16 in. wide by 44 in. long with seam centered and test using digital field tensiometer for peel and shear. Tested specimen shall not fail in seam. Cut remaining sample into three equal parts (minimum 13 in. each) and distribute as follows:

- One portion of Installer for laboratory testing, 16 in. x 13 in.
- One portion for independent laboratory testing, 16 in. x 16 in.
- One portion to Engineer for archive storage, 16 in. x 13 in.

4. Installer's Laboratory Testing:

a. Submit test results to QC Personnel as soon as they become available.

5. Independent Laboratory Testing:

a. Test for "seam strength" and "peel adhesion" according to ASTM D4437. Minimum acceptable values are indicated in Part 2 - Seam Properties. Test at least five replicate specimens for each test method. To be acceptable, four out of five replicates shall pass seam strength and peel adhesion criteria in Part 2.

Report test results to Engineer no more than 48 h after laboratory receives samples.

6. Procedures for Destructive Test Seam Failure:

   a. Following procedures shall apply whenever seam sample fails field destructive test:

      - Reconstruct seam between any two passed test locations; or
      - Retrace welding path to intermediate location, at 10 ft minimum from location of failed test in each direction, and take small samples for additional field tests. If additional samples pass test, then seam shall be reconstructed between those locations on either side of original failed location. If any sample fails, the process shall be repeated.

   b. In any case, acceptable seams shall be bounded by two passed test locations (i.e., above procedure shall be followed in both directions from original failed location), and one sample for laboratory destructive testing shall be taken within reconstructed area.

   c. In event that seam sample fails laboratory destructive test (whether conducted by independent laboratory or by Installer's laboratory), then above procedures shall be followed considering laboratory tests exclusively. Because final seam must be bounded by two passed test locations, it may then be necessary to take one or more samples for laboratory testing in addition to one required in reconstructed seam area.

J. Defects and Repairs:

1. Identification: Broom or wash geomembrane if amount of dust or mud inhibits inspection.
2. Evaluation: Nondestructively test each suspect location in seam and nonseam areas. Repair each location which fails nondestructive testing.
3. Repair Procedures:

a. Repair defective seams by reconstruction.

b. Repair excessive wrinkles by cutting and seaming.

c. Repair tears or pinholes by seaming or patching.

d. Repair blisters, larger holes, undispersed raw materials, and contamination by foreign matter by patches.

e. Surfaces of geomembrane to be patched shall be abraded no more than 1 hour prior to repair.

f. Seams used in repairs shall be approved extrusion or fusion welded seams and may be subjected to same destructive test procedure as outlined for other seams.

g. Patches shall be round or oval in shape, made of same geomembrane, extend a minimum of 6 in. beyond edge of defects, and applied using approved methods only.

4. Seam Reconstruction Procedures:

a. Seam reconstruction for fusion process shall be achieved by cutting out existing seam and welding in replacement strip, or by extrusion welding if there is sufficient flap width at edge of previous fusion weld.

b. Seam reconstruction for extrusion process shall be achieved by grinding and rewelding small seam sections, or by capping or topping for large seam sections.

5. Verification of Repairs:

a. Test each repair nondestructively.

b. Repairs passing nondestructive test shall be taken as indication of adequate repair.

c. Failed tests indicate repair shall be redone and retested in passing test results.

K. Geomembrane Acceptance:

1. Installer shall retain ownership and responsibility for geomembrane until acceptance by Engineer. Geomembrane installation shall be accepted by Engineer when:

a. Installation is finished.

b. Documentation of installation is completed, including inspector's final report and reporting of all geomembrane test results.

c. Confirmation of adequacy of field seams and repairs, including associated testing, is complete.

## 3.04 MATERIALS IN CONTACT WITH GEOMEMBRANE

A. General:

1. Carefully install materials in contact with geomembrane surfaces to minimize damage potential.
2. Clamps, clips, bolts, nuts, or other fasteners used to secure geomembrane to each appurtenance shall have lifespan equal to or exceeding geomembrane's.

B. Pipes and Other Appurtenances:

1. Install geomembrane around appurtenances, such as pipes, protruding through geomembrane as shown in Drawings. Unless otherwise specified, initially install geomembrane sleeve or shield around each appurtenance prior to geomembrane installation.
2. After material is placed and seamed, complete final field seam connection between appurtenance sleeve or shield and geomembrane. Maintain sufficient initial overlap of appurtenance sleeve so shifts in location of geomembrane can be accommodated.
3. Extreme care shall be taken while seaming around appurtenances because both nondestructive and destructive seam testing might not be feasible. Do not damage geomembrane while making connections to appurtenances.

## 3.05 FIELD QUALITY CONTROL

A. The CQA Official will observe the placement of the geomembrane.

B. Perform testing in accordance with the following:

## GEOMEMBRANE TESTING

| PROPERTY | TEST FREQUENCY |
|---|---|
| Thickness | 1 per 50,000 sf |
| Density | 1 per 50,000 sf |
| Melt Flow Index | 1 per 50,000 sf |
| Tensile Strength At Break | 1 per 50,000 sf |
| Elongation At Break | 1 per 50,000 sf |
| Modulous Of Elasticity | 2 samples |
| Environmental Stress Crack | 5 samples from the polymer used to fabricate the geomembrane |

****END OF SECTION ****

**SECTION 02831**
**CHAIN LINK FENCE CONSTRUCTION**

# PART 1 GENERAL

## 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and such miscellaneous items as necessary for installation of a chain link fence system, as specified herein and shown on the Plans. The work covered by this Section shall include repair or replacement of the security fence and barbed wire in areas affected by construction and new installation in the northeast area, as shown on the Plans.

B. Contractor shall remove and reuse existing fencing where possible in the judgment of the Engineer.

C. Contractor shall install fencing according to manufacturer's specifications unless otherwise indicated and specified herein.

## 1.02 RELATED WORK

A. SECTION 02110 Clearing, Stripping and Grubbing

## 1.03 SUBMITTALS

A. Product Data: Steel Fences and Gates

1. Contractor Shall submit to the Engineer two (2) copies of manufacturer's technical data, details of fabrication, and installation instructions and procedures for steel fences and gates. Transmit a copy of each instruction to the installer.

B. Samples:

1. Contractor shall submit to the Engineer three (3) samples approximately 6 in. long, or 6 in. square of fence material, framework members, and typical accessories.

C. Certificates:

1. Submit to the Engineer manufacturer's certification that materials meet specification requirements.

## 1.04 QUALITY ASSURANCE

A. Standards of Manufacture: Standards of Manufacture shall comply with the standards of the Chain Link Fence Manufacturer's Institute for "Galvanized Steel Chain Link Fence Fabric" and as herein specified.

B. Provide each type of steel fence and gates as a complete unit produced by a single manufacturer, including necessary erection accessories, fittings and fastenings.

C. Erector Qualifications: Minimum of 5 years experience installing similar fencing.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Pipe sizes indicated are commercial pipe sizes.

B. Tube sizes indicated are nominal outside dimension (OD).

C. H-section sizes are nominal flange dimensions.

D. Roll-formed section sizes are the nominal outside dimensions.

E. Finish for framework and appurtenances shall contain not less than the minimum weight of zinc per square foot (psf), complying with the following:

1. Pipe: ASTM A 53 (2.0 oz. zinc per square foot)

2. Square tubing: ASTM A 123 (2.0 oz. zinc per square foot)

3. H-sections: ASTM A 123 (2.0 oz. zinc per square foot)

4. Hardware and Accessories: ASTM A 153 (zinc weight per manufacturer's standards).

F. All fence components shall be galvanically compatible.

## 2.02 FABRIC

A. Fabric shall be 9 gauge steel wires, 2 in. diamond mesh; both top and bottom selvages twisted and barbed for fabric over 72 inches high. Finish shall be hot dipped galvanized, ASTM A 392, Class II.

## 2.03 POSTS, RAILS AND BRACES

A. End, Corner, and Pull Posts:

1. Furnish end and corner posts of the minimum sizes and weights as follows:

a. Up to 6 foot fabric height:

1) 2.375 inch OD pipe weighing 3.65 pounds per linear foot.

2) 2.50 inch square tubing weighing 5.79 pounds per linear foot.

b. Over 6 foot fabric height:

1) 2.876 inch OD pipe weighing 4.79 pounds per linear foot.

2) 2.60 inch square tubing weighing 5.79 lbs per linear foot.

B. Line Posts:

1. Furnish line posts of the minimum sizes and weights as follow is: Space posts 10 foot on the center maximum, unless otherwise indicated.

a. Up to 6 foot fabric height:
1.90 inch OD pipe weighing 2.70 pounds per linear foot.

b. Over 6 foot fabric height:

1) 2.375 inch OD pipe weighing 3.65 pounds per linear foot.

C. Top Rails:

1. Top rails shall be furnished unless otherwise indicated, of the following:

a. 1.66 inch OD pipe weighing 2.27 pounds per linear foot.

D. Post Brace Assembly:

1. Furnish bracing assemblies at end posts and at both sides of corner posts, with the horizontal brace located at mid-height of the fabric.

2. Use 1.66 inch OD pipe weighing 2.27 pounds per linear foot for horizontal brace and 3/8 inch diameter rod with turnbuckle for diagonal truss.

E. Tension Wire:

1. Furnish tension wire consisting of galvanized 7 gauge coiled spring wire. Locate at bottom of fabric only.

F. Post Tops:

1. Post tops shall be pressed steel, wrought iron, or malleable iron of SG70A (or equivalent) of ASTM B-26 or B-108, designed as a weathertight closure cap (for tubular posts).

G. Stretcher Bars:

1. Stretcher bars shall be one piece lengths equal to full height of fabric, with a minimum cross-section of 3/16 inch x 3/4 inch. Provide one stretcher bar for each gate and end post, and 2 for each corner and pull post, except where fabric is integrally woven into the post.

H. Stretcher Bar Bands:

1. Stretcher bar band shall be steel, wrought iron, or malleable iron, spaced not over 15 inch on center to secure stretcher bars to end, corner, pull, and gate posts.

## 2.04 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Wire Ties:

1. For tying fabric to line posts, use 9 gauge wire ties spaced 12 inches on center. For tying fabric to rails and braces, use 9 gauge wire ties spaced 24 inches on center. For tying fabric to tension wire, use 11 gauge hog rings spaced 24 inches on center. Finish of ties shall match fabric finish.

B. Concrete:

1. Provide concrete consisting of portland cement complying with ASTM C-150, aggregates complying with ASTM C-33, and clean water. Mix materials to obtain concrete with a minimum 28-day compressive strength of

2500 psi, 1 inch maximum size aggregate, maximum 3 inch slump, and 2 percent to 4 percent entrained air.

C. Warning Signs:

1. Warning signs corresponding to, contaminated site, hazardous waste cover, contact number in case of emergency, and others as specified by the Engineer shall be placed on the site. These warning signs shall comply with applicable codes (e.g., OSHA, NFPA, etc.).

2. The warning signs shall be at least 2 feet by 2.5 feet, made of a durable weather resistant material with a white background and red lettering of a size readable from a distance of at least 10 ft.

3. Warning signs shall be placed at all entrances and other access points and around the perimeter of any contaminated sites, treatment system areas and sites with hazardous waste covers, at intervals no greater than 200 feet and in sufficient numbers as to be seen from any approach. Contractor is responsible for supplying, installing and maintaining the warning signs.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. Security fence installation shall be located as shown on the Plans. Height of security fence shall be as noted on the Plans.

B. Excavation:

1. Drill holes of diameters and spacings as shown on the Plans, for post footings in firm, undisturbed or compacted soil.

a. Post holes shall be in true alignment and of sufficient size to provide a permanent foundation of concrete. Concrete shall be poured against undisturbed or compacted earth sides and bottom. All holes shall be 30 inches deep with posts and corner posts placed in the concrete to a depth of 30 inches and the gate posts shall be set in the concrete to a depth of 48 inches below the surface when in firm, undisturbed soil. Holes shall be well centered on the posts. A minimum diameter of 12 inches shall be required for all post holes.

C. Setting Posts:

1. Remove loose and foreign materials from sides and bottoms of holes, and moisten soil prior to placing concrete.

   a. Center and align posts in holes to appropriate height specified in Paragraph 3.1 B.1.a above bottom of excavation.

   b. Place concrete around posts in a continuous pour, and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations. The top of concrete shall extend 2 inches above finish grade.

   c. Trowel finish tops of footings, and slope or dome to direct water away from posts. Extend footings for gate posts to the underside of bottom hinge. Set keeps, stops, sleeves and other accessories into concrete as required.

   d. Keep exposed concrete surfaces moist for at least 7 days after placement, or cure with membrane curing materials, or other acceptable curing method.

D. Concrete Strength:

1. Allow concrete to attain at least 75% of its minimum 28-day compressive strength, but in no case sooner than 7 days after placement, before rails, tension wires, barbed wire, or fabric is installed. Do not stretch and apply

tension to fabric and wires, and do not hang gates until the concrete has attained its full design strength.

E. Top Rails:

1. Run rail continuously through post caps or extension arms, bending to radius for curved runs. Provide expansion couplings as recommended by fencing manufacturer.

F. Brace Assemblies:

1. Install braces so posts are plumb when diagonal rod is under proper tension.

G. Tension Wire:

1. Install tension wires by weaving through the fabric and tying to each post with not less than 6 gauge galvanized wire, or by securing the wire to the fabric.

H. Fabric:

1. Leave approximately 3 inches between finish grade and bottom salvage, except where bottom of fabric extends into concrete. Pull fabric taut and tie to posts, rails, and tension wires. Install fabric on security side of fence, and anchor to framework so that fabric remains in tension after pulling force is released.

I. Repairs:

1. Repair damaged coatings in the shop or during field erection by recoating with manufacturer's recommended repair compounds, applied per manufacturer's directions.

J. Stretcher Bars:

1. Thread through or clamp to fabric 4 inches on center, and secure to posts with metal bands spaced 15 inches on center.

L. Tie Wires:

1. Use U-shaped wire, conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least 2 full turns. Bend ends of wire to minimize hazard to persons or clothing.

M. Fasteners:

1. Install nuts for tension band and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

## 3.02 ERECTION TOLERANCES

A. Maximum variation from plumb: 1 inch

B. Maximum offset from true position: 1 inch

****END OF SECTION ****

# SECTION 02936
# SEEDING

## PART 1 GENERAL

### 1.01 WORK INCLUDED

A. Preparation of subsoil.

B. Placing topsoil.

C. Fertilizing.

D. Seeding.

E. Hydroseeding.

F. Mulching.

G. Maintenance.

### 1.02 RELATED WORK

A. Section 02220 - Earthwork.

### 1.03 REFERENCES

A. Federal Specification (FS).

1. O-F--241 - Fertilizers, Mixed, Commercial.

## 1.04 DEFINITIONS

A. Weeds: Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

## 1.05 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies for fertilizer and herbicide composition.

## 1.06 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

## 1.07 TESTS

A. Provide analysis of topsoil fill under provisions of Section 02220.

B. Analyze to ascertain percentage of nitrogen, phosphorus, potash, organic matter content, and pH value.

C. Submit minimum 10 oz sample of topsoil proposed.

D. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

## 1.08 MAINTENANCE DATA

A. Submit maintenance data for continuing Owner maintenance under provisions of Section 01700.

B. Include maintenance instructions, cutting method, and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

## 1.09 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site.

B. Store and protect products.

C. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.

D. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

## 1.10 MAINTENANCE SERVICE

A. Maintain seeded area for twelve months from Date of Substantial Completion.

# PART 2 PRODUCTS

## 2.01 GENERAL

## 2.02 SEED MIXTURE

A. Seed Mixture:

| Species | Min. % Purity | Application mixture |
|---|---|---|
| Big Bluestem | 98% | 3 lbs/acre |
| Indiangrass | 98% | 4 lbs/acre |
| Little Bluestem | 98% | 6 lbs/acre |
| Annual Rye Grass | 98% | 15 lbs/acre |
| Sideoats Grama | 98% | 5 lbs/acre |

## 2.03 SOIL MATERIALS

A. Topsoil: Imported sandy loam; reasonably free of subsoil, roots, grass, excess weeds, stone limited to 1 inch maximum size, and foreign matter; acidity range (pH) of 5.5 to 7.5; containing a minimum of 5 percent organic matter.

## 2.04 ACCESSORIES

A. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.

B. Fertilizer: FS O-F-241, Type I, Grade A; recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil to the following proportions: Nitrogen 19 percent, phosphoric acid 19 percent, soluble potash 19 percent.

C. Erosion Fabric: Jute matting, open weave.

D. Stakes: Softwood lumber, chisel pointed.

E. String: Inorganic fiber.

# PART 3 EXECUTION

## 3.01 INSPECTION

A. Verify that prepared soil base is ready to receive the Work of this Section.

B. Beginning of installation means acceptance of existing site conditions.

## 3.02 PREPARATION OF SUBSOIL

A. Prepare subsoil to eliminate uneven areas and low spots. Maintain lines, levels, profiles, and contours. Make changes in grade gradual. Blend slopes into level areas.

B. Remove foreign materials, weeds, and undesirable plants and their roots. Remove contaminated subsoil.

C. Scarify subsoil to a depth of 3 inches where topsoil is to be placed. Repeat cultivation in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

## 3.03 PLACING TOPSOIL

A. Spread topsoil to a minimum depth of 6 inches over area to be seeded. Rake until smooth.

B. Place topsoil during dry weather and on dry, unfrozen subgrade.

C. Remove vegetable matter and foreign non-organic material while spreading.

D. Grade to eliminate rough, low, or soft areas, and to ensure positive drainage.

## 3.04 FERTILIZING

A. Apply fertilizer in accordance with manufacturer's instructions at a rate of 100 lb/acre.

B. Apply after smooth raking of topsoil and prior to roller compaction.

C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.

D. Mix thoroughly into upper 2 inches of topsoil.

## 3.05 SEEDING

A. Apply seed at a rate of 4 lbs per 1000 sq ft evenly in two intersecting directions. Rake in lightly. Do not seed area in excess of that which can be mulched on same day.

B. Planting Season: May 1 to October 6.

C. Do not sow immediately following rain, when ground is too dry, or during windy periods.

D. Roll seeded area with roller not exceeding 112 lbs PSF.

E. Immediately following seeding and compacting, apply mulch to a thickness of 1/4 inches (5 mm).

## 3.06 HYDROSEEDING

A. Apply seeded slurry at a rate of 5 lbs per 1000 sq ft evenly in two intersecting directions, with a hydraulic seeder. Do not hydroseed area in excess of that which can be mulched on same day.

B. Immediately following seeding, apply mulch to a thickness of 1/4 inches.

## 3.07 SEED PROTECTION

A. Cover seeded slopes where grade is 4 inches per foot, or greater, with erosion fabric. Roll fabric onto slopes without stretching or pulling.

C. Lay fabric smoothly on surface, bury top end of each section in 6 inch deep excavated topsoil trench. Provide 12 inch overlap of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil.

D. Secure outside edges and overlaps at 36 inch intervals with stakes.

E. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.

F. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches.

## 3.08 MAINTENANCE

A. Control growth of weeds with appropriate mowing cycles.

B. Immediately reseed areas which show bare spots.

****END OF SECTION ****